LITCHFIELD ENGINEERING

Civil Engineering & Development Services

TECHNICAL INFORMATION REPORT
for the
ALTMAN MERCER ISLAND-MIDDLE LOT SFR

Prepared for:

Ben Altman
91XX SE 64th Street
Mercer Island, WA 98040

Prepared By:
Keith A. Litchfield, P.E.

Date Issued: April 6, 2020

KEITH A. LITCHFIELD
29476

4/6/2020

12840 81ST AVENUE NE ♦ KIRKLAND, WA 98034
PH 425-821-5038 FAX 425-821-5739

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

1. PROJECT OVERVIEW

The proposed project involves the construction of a new single-family residence. The new residence will take access from SE 64th Street via a new paved driveway. Developed stormwater will be collected, detained, and conveyed to the existing conveyance system within East Mercer Way. The existing site is undeveloped and covered with vegetation and trees. There is a high point onsite located near the southern property line. From the high point the site slopes steeply down to the northeast/east and southwest. Per City of Mercer Island GIS mapping, the site is within a mapped potential landslide hazard, seismic hazard, and erosion hazard area. Please refer to the Geotechnical Engineering Study prepared by Pan Geo, Inc. for more information regarding work within the critical areas.

Existing Adjacent Development:

Existing development adjacent to the subject site includes the following:
North – SE 64th Street / New Hope International Church
East – Single-Family Residence
South – Single-Family Residence
West – Single-Family Residence

2. MINIMUM REQUIREMENTS

Flow Chart #1: Flow Chart for Determining Requirements for New Development was utilized to determine which requirements apply to the project. Since the project is proposing greater than 5,000 SF all Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas. Please refer to page #4 for Flow Chart #1.

Minimum Requirements #1-9:

Minimum Requirement No. 1 – Preparation of Stormwater Site Plans

A Stormwater Site Plan has been prepared for review by the City.

Minimum Requirement No. 2 – Construction Stormwater Pollution Prevention (SWPP)

A SWPP (i.e. TESC) plan is included in the project submittal.

Minimum Requirement No. 3 – Source Control of Pollution

Proposed construction source control measures include silt fence and temporary and permanent seeding. Operational and structural BMPs are not proposed. Please refer to Section 3: Construction Stormwater Pollution Prevention Plan for additional BMPs.

Minimum Requirement No. 4 – Preservation of Natural Drainage Systems and Outfalls

The natural drainage pattern and discharges from the site will be maintained to the maximum extent practicable. No significant adverse impacts to the downstream system are expected or anticipated.

Minimum Requirement No. 5 – On-site Stormwater Management

Flow Chart #2 Flow Chart for Determining LID MR #5 Requirements was utilized to determine the requirements to meet On-site Stormwater Management. Per Flow Chart #2, List #2 was used to determine the On-site Stormwater Management BMPs feasible for the project. Please refer to Flow Chart #2 on page 5.

List #2 Analysis:

Per Section 2.5.5 of the Stormwater Management Manual for Western Washington, the BMPs must be considered in the order listed in List #2 for each surface. The first BMP considered feasible must be implemented to the maximum extent feasible. Below is the feasibility evaluation of the BMPs in the order listed.

Lawn and Landscaped areas:

1. Post Construction Soil Quality and Depth – The onsite slopes are steeper than 30%, therefore soil amendment is infeasible.

Roofs:

1. Full Dispersion – Infeasible due to steep slopes and lack of vegetated flow paths.
2. Rain Gardens or Bioretention – Infeasible; per city mapping the site is labeled as “non-infiltrating”.
3. Downspout Dispersion Systems – Infeasible due to steep slopes.
4. Perforated Stub-out Connection – Infeasible; site is mapped as “non-infiltrating”.

Other Hard Surfaces:

1. Full Dispersion – Infeasible due to steep slopes and lack of vegetated flow paths.
2. Permeable Pavement – Infeasible; per city mapping the site is labeled as “non-infiltrating”.

Per the above BMP feasibility analysis, no on-site stormwater BMPS are feasible. Therefore, per Mercer Island City Code 15.09.050A(2), on-site detention is required. The onsite detention tank was sized using Table 1 from the City of Mercer Island’s On-site Detention Design Requirements. Table 1 is provided as Appendix B. Please see below for the proposed detention tank design/analysis.

New Plus Replaced Impervious Surfaces:

Roof = 3,945 SF
Driveway = 2,323 SF
Walk/Patio/Stairs = 363 SF
Total Impervious = 6,631 SF

Proposed Detention Tank Design per City of Mercer Island’s Table 1:

Tank Diameter = 5 ft
Length = 43 ft
1st Orifice Diameter = 0.5 in
Height of 2nd Orifice = 3.6 ft
2nd Orifice Diameter = 1.6 in

Minimum Requirement No. 6 – Runoff Treatment

The proposed pollution generating impervious surface (PGIS) is less than 5,000 SF (Proposed PGIS = 2,323 SF), therefore runoff treatment is not required.

Minimum Requirement No. 7 – Flow Control

Per Section 2.5.7 of the SWMMWW a formal flow control facility is required if the following thresholds are exceeded;

- the total effective impervious surface is 10,000 square feet or more
- ¾ acres or more of native vegetation converted to lawn or landscape, or 2.5 acres or more of native vegetation converted to pasture
- A 0.15 cubic feet per second increase in the 100-year flow frequency

Since the project is proposing less than 10,000 square feet of effective impervious surface, converting less than ¾ acres to lawn or pasture, and increasing the 100-year flow frequency by less than 0.15 CFS a formal flow control facility is not required. Please see below for the WWHM analysis demonstrating that the 100-year flow frequency will not be increased by greater than 0.15 CFS. Please refer to Appendix A for the WWHM output.

WWHM Analysis:

For the purpose of this analysis the "Site Area" is assumed to be the clearing limits for the project.

Predeveloped:

C, Forest, Steep = 0.26 ac
<u>Total Site Area = 0.26 ac</u>

Developed:

Impervious, flat = 0.10 ac (roof/walkways)
Impervious, mod = 0.05 ac (Driveway)
C, Lawn, steep = 0.11 ac
<u>Total Site Area = 0.26 ac</u>

Predeveloped 100-year Flow Frequency = 0.0359 CFS
Developed 100-year Flow Frequency = 0.1650 CFS
Increase in 100-year Flow Frequency = 0.1291 CFS

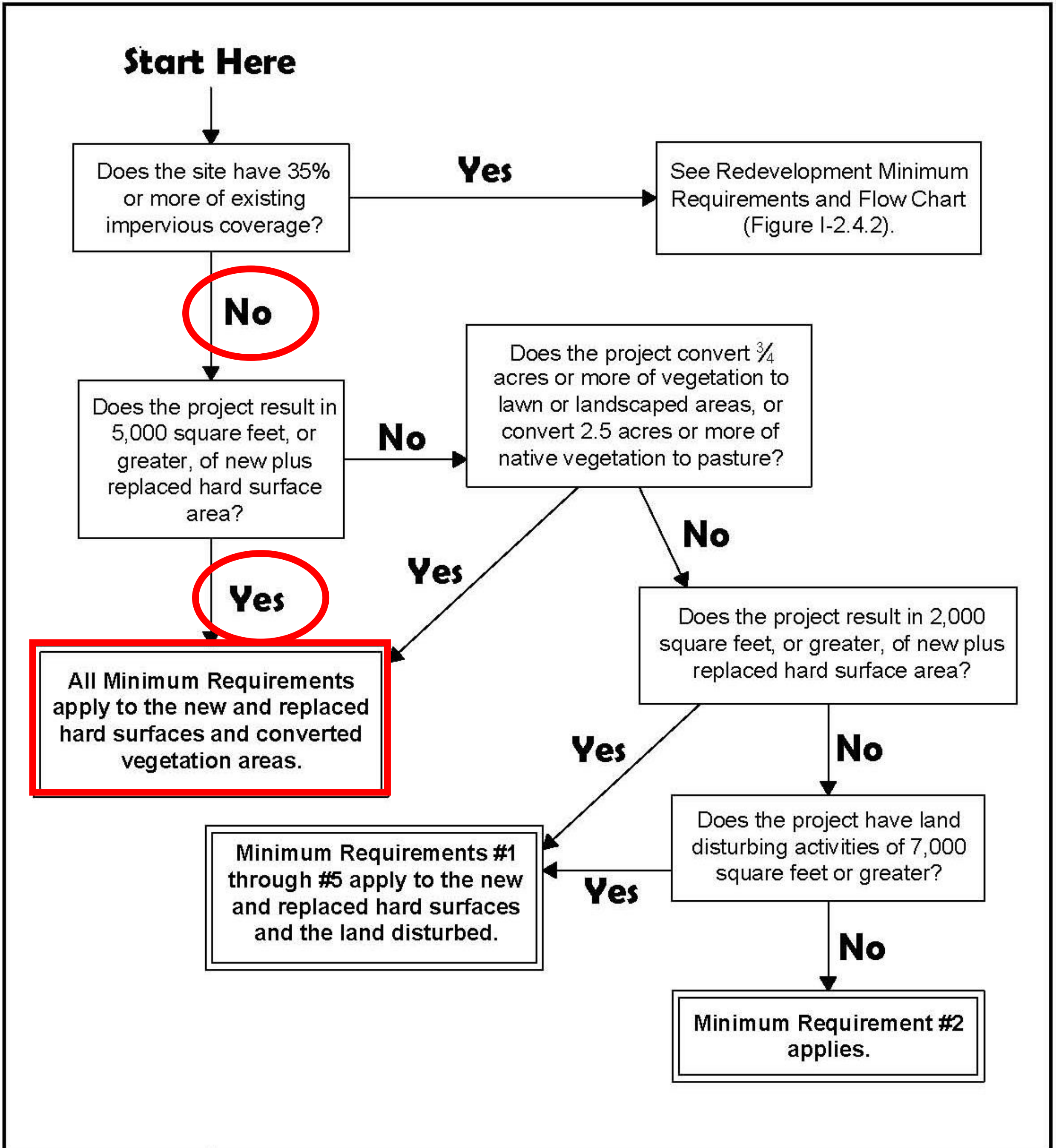
Minimum Requirement No. 8 – Wetlands Protection

N/A – There are no known wetlands on or adjacent to the project site.

Minimum Requirement No. 9 – Operations and Maintenance

A draft Operations and Maintenance Manual is included in Appendix C.

Flow Chart #1:

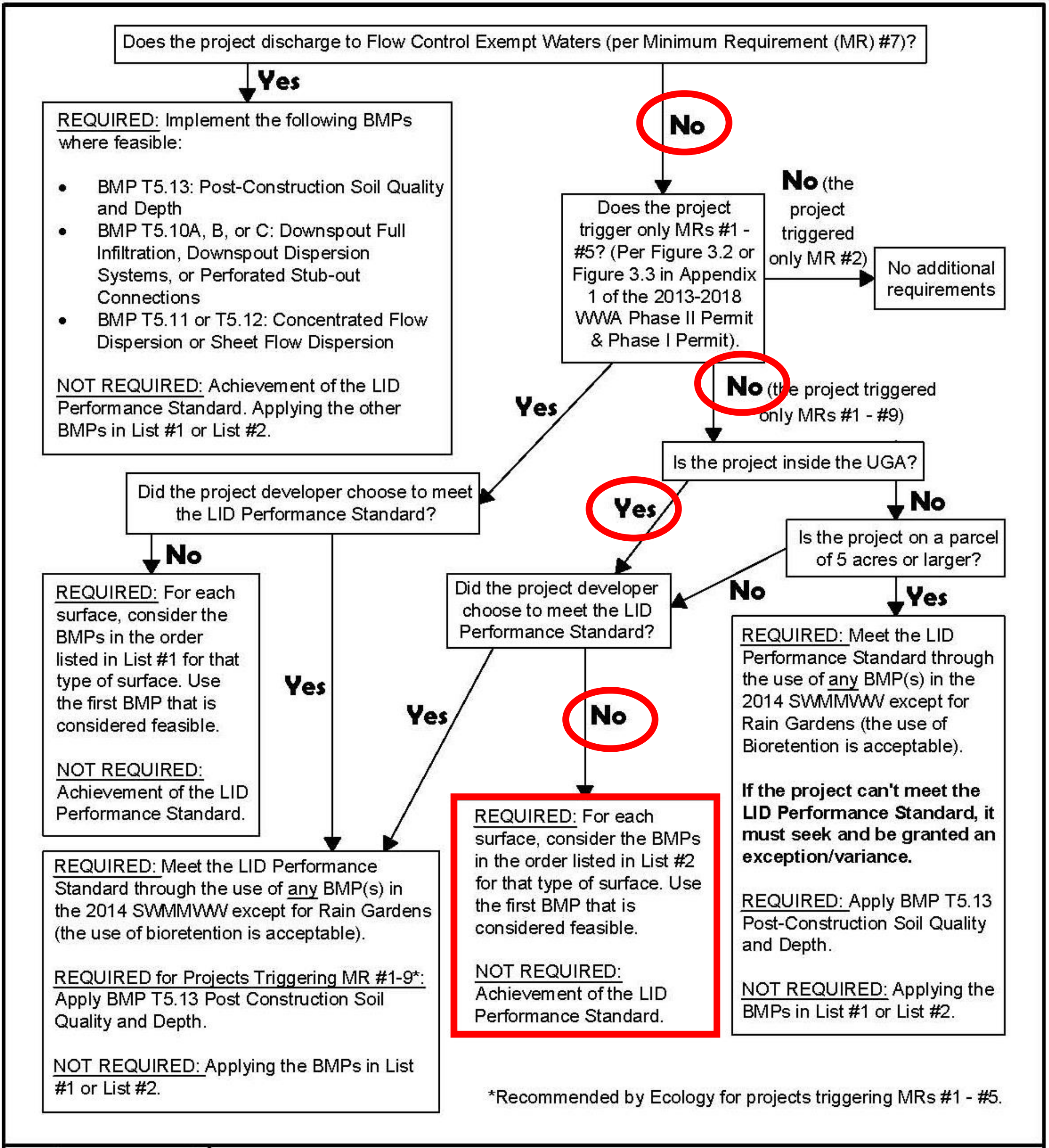


DEPARTMENT OF
ECOLOGY
State of Washington

Figure I-2.4.1
Flow Chart for Determining Requirements for New Development

Revised June 2015

Flow Chart #2:



Does the project discharge to Flow Control Exempt Waters (per Minimum Requirement (MR) #7)?

REQUIRED: Implement the following BMPs where feasible:

- BMP T5.13: Post-Construction Soil Quality and Depth
- BMP T5.10A, B, or C: Downspout Full Infiltration, Downspout Dispersion Systems, or Perforated Stub-out Connections
- BMP T5.11 or T5.12: Concentrated Flow Dispersion or Sheet Flow Dispersion

NOT REQUIRED: Achievement of the LID Performance Standard. Applying the other BMPs in List #1 or List #2.

Does the project trigger only MRs #1 - #5? (Per Figure 3.2 or Figure 3.3 in Appendix 1 of the 2013-2018 WWA Phase II Permit & Phase I Permit).

No additional requirements

Is the project inside the UGA?

Did the project developer choose to meet the LID Performance Standard?

Is the project on a parcel of 5 acres or larger?

REQUIRED: For each surface, consider the BMPs in the order listed in List #1 for that type of surface. Use the first BMP that is considered feasible.

NOT REQUIRED: Achievement of the LID Performance Standard.

Did the project developer choose to meet the LID Performance Standard?

REQUIRED: Meet the LID Performance Standard through the use of any BMP(s) in the 2014 SWMMWW except for Rain Gardens (the use of Bioretention is acceptable).

If the project can't meet the LID Performance Standard, it must seek and be granted an exception/variance.

REQUIRED: Apply BMP T5.13 Post-Construction Soil Quality and Depth.

NOT REQUIRED: Applying the BMPs in List #1 or List #2.

REQUIRED: Meet the LID Performance Standard through the use of any BMP(s) in the 2014 SWMMWW except for Rain Gardens (the use of bioretention is acceptable).

REQUIRED for Projects Triggering MR #1-9*: Apply BMP T5.13 Post Construction Soil Quality and Depth.

NOT REQUIRED: Applying the BMPs in List #1 or List #2.

REQUIRED: For each surface, consider the BMPs in the order listed in List #2 for that type of surface. Use the first BMP that is considered feasible.

NOT REQUIRED: Achievement of the LID Performance Standard.

*Recommended by Ecology for projects triggering MRs #1 - #5.

DEPARTMENT OF
ECOLOGY
State of Washington

Figure I-2.5.1
Flow Chart for Determining LID MR #5 Requirements

Revised June 2015

3. CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

The project SWPPP addresses the 13 required elements as follows:

Element 1 – Preserve Vegetation/Mark Clearing Limits – Clearing limits will be delineated with silt fence and orange construction fencing.

Element 2 – Establish Construction Access - A quarry spall construction entrance and a wheel wash will be provided if warranted.

Element 3 – Control Flow Rates – Flow rates will be controlled by using SWPP Element 4 sediment controls as necessary.

Element 4 – Install Sediment Controls – Silt fencing will be implemented and is expected to provide construction stormwater sediment control during construction.

Element 5 – Stabilize Soils – Stockpiled or unworked soils will be protected during construction by covering with plastic or temporary or permanent seeding. All exposed soils will be landscaped or seeded at the conclusion of the project.

Element 6 – Protect Slopes – Cut slopes will be protected during construction with plastic sheeting per BMP C123. Upon project completion, landscape planting and seeding will be implemented to provide permanent stabilization.

Element 7 – Protect Drain Inlets – The existing and newly constructed conveyance system inlets in the vicinity of the project site will be protected with catch basin filters during construction.

Element 8 – Stabilize Channels and Outlets – Construction will occur during the dry weather. No storm drainage channels or ditches shall be constructed either temporary or permanent. A small swale shall be graded to convey yard drainage around the structure using a shallow slope; it shall be seeded after grading and stabilized.

Element 9 – Control Pollutants – The small size of this project will limit the opportunity for discharge of pollutants. Waste/demolition debris will not be stockpiled, fueling will be done off-site and concrete trucks will be washed out off-site.

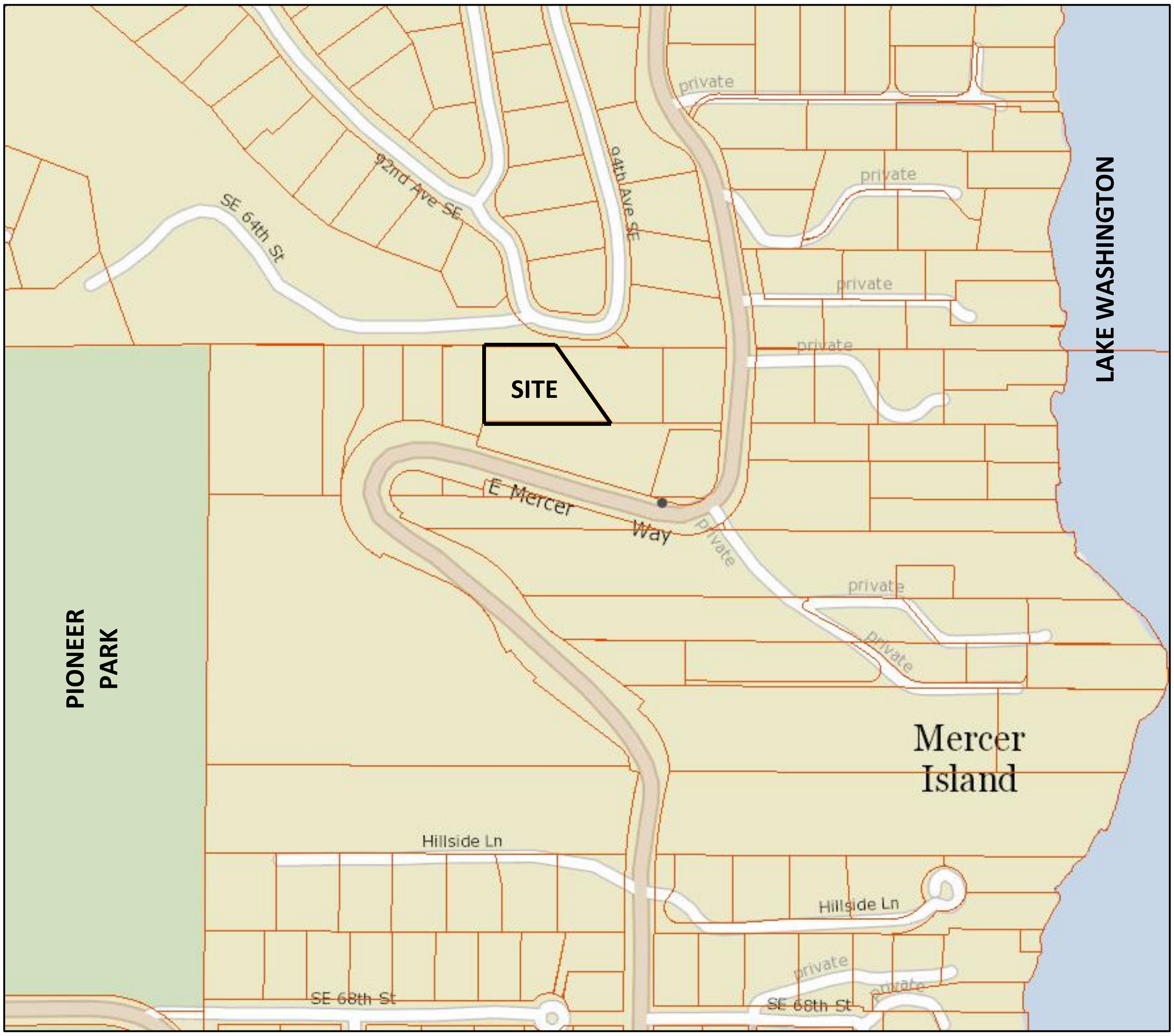
Element 10 – Control De-watering – De-watering is not anticipated.

Element 11 – Maintain BMPs – BMPs will be maintained as necessary to assure continued functioning.

Element 12 – Manage the Project – An inspector (sites less than 1 acre) will be present or on call to ensure BMPs are maintained and assess effectiveness of ESC measures. Rainy season requirements will be implemented if necessary.

Element 13 – Protect LID BMPs – N/A. No LID BMPs are proposed.

Figure 1 – Vicinity Map



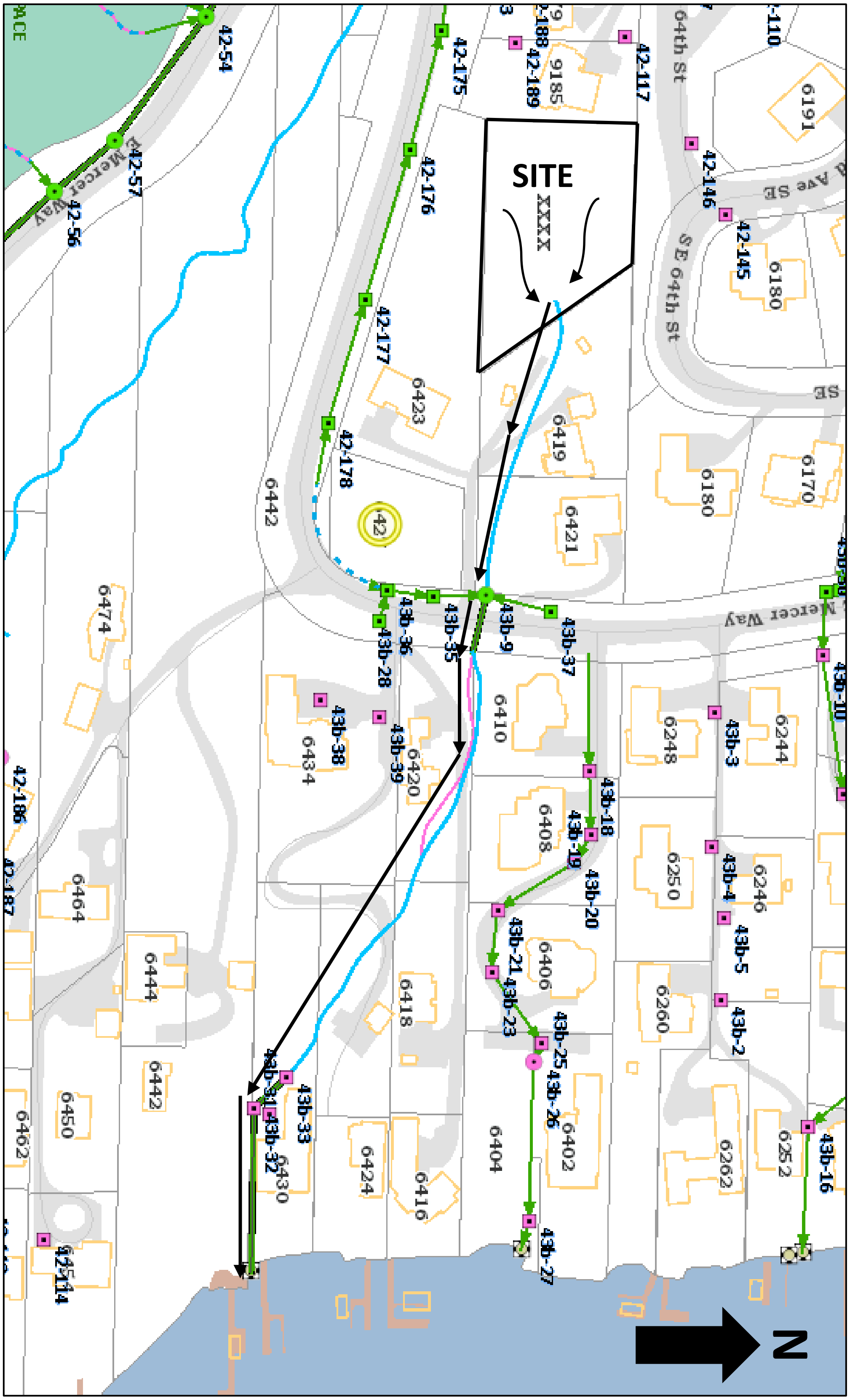


Figure 2 – Downstream Map

Appendix A
WWHM OUTPUT

WWHM2012
PROJECT REPORT

Project Name: LE Altman Middle Lot FC Analysis 4-6-20
Site Name: Middle Lot
Site Address: 6427 E Mercer Way
City : MI
Report Date: 4/6/2020
Gage : Seatac
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.00
Version Date: 2019/09/13
Version : 4.2.17

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	**acre**
C, Forest, Steep	**.26**
Pervious Total	**0.26**

Impervious Land Use	**acre**
Impervious Total	**0**
Basin Total	**0.26**

Element Flows To:

Surface	**Interflow**	**Groundwater**

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Lawn, Steep	.11
Pervious Total	0.11

Impervious Land Use	acre
ROADS FLAT	0.1
ROADS MOD	0.05
Impervious Total	0.15
Basin Total	0.26

Element Flows To:

Surface	Interflow	Groundwater

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.26
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.11
Total Impervious Area:0.15

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.011635
5 year	0.018533
10 year	0.023012
25 year	0.028428
50 year	0.032254
100 year	0.035892

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.070984
5 year	0.093698
10 year	0.109663
25 year	0.130931
50 year	0.147593
100 year	0.164976

Appendix B
On-site Detention Tank Sizing Table

Table 1

ON-SITE DETENTION DESIGN FOR PROJECTS BETWEEN 500 SF AND 9,500 SF NEW PLUS REPLACED IMPERVIOUS SURFACE AREA

New and Replaced Impervious Surface Area (sf)	Detention Pipe Diameter (in)	Detention Pipe Length (ft)		Lowest Orifice Diameter (in)(3)		Distance from Outlet Invert to Second Orifice (ft)		Second Orifice Diameter (in)	
		B soils	C soils	B soils	C soils	B soils	C soils	B soils	C soils
500 to 1,000 sf	36"	30	22	0.5	0.5	2.2	2.0	0.5	0.8
	48"	18	11	0.5	0.5	3.3	3.2	0.9	0.8
	60"	11	7	0.5	0.5	4.2	3.4	0.5	0.6
1,001 to 2,000 sf	36"	66	43	0.5	0.5	2.2	2.3	0.9	1.4
	48"	34	23	0.5	0.5	3.2	3.3	0.9	1.2
	60"	22	14	0.5	0.5	4.3	3.6	0.9	0.9
2,001 to 3,000 sf	36"	90	66	0.5	0.5	2.2	2.4	0.9	1.9
	48"	48	36	0.5	0.5	3.1	2.8	0.9	1.5
	60"	30	20	0.5	0.5	4.2	3.7	0.9	1.1
3,001 to 4,000 sf	36"	120	78	0.5	0.5	2.4	2.2	1.4	1.6
	48"	62	42	0.5	0.5	2.8	2.9	0.8	1.3
	60"	42	26	0.5	0.5	3.8	3.9	0.9	1.3
4,001 to 5,000 sf	36"	134	91	0.5	0.5	2.8	2.2	1.7	1.5
	48"	73	49	0.5	0.5	3.6	2.9	1.6	1.5
	60"	46	31	0.5	0.5	4.6	3.5	1.6	1.3
5,001 to 6,000 sf	36"	162	109	0.5	0.5	2.7	2.2	1.8	1.6
	48"	90	59	0.5	0.5	3.5	2.9	1.7	1.5
	60"	54	37	0.5	0.5	4.6	3.6	1.6	1.4
6,001 to 7,000 sf	36"	192	128	0.5	0.5	2.7	2.2	1.9	1.8
	48"	102	68	0.5	0.5	3.7	2.9	1.9	1.6
	60"	64	43	0.5	0.5	4.6	3.6	1.8	1.5
7,001 to 8,000 sf	36"	216	146	0.5	0.5	2.8	2.2	2.0	1.9
	48"	119	79	0.5	0.5	3.8	2.9	2.2	1.7
	60"	73	49	0.5	0.5	4.5	3.6	2.0	1.6
8,001 to 8,500 sf(1)	36"	228	155	0.5	0.5	2.8	2.2	2.1	1.9
	48"	124	84	0.5	0.5	3.7	2.9	1.9	1.8
	60"	77	53	0.5	0.5	4.6	3.6	2.0	1.6
8,501 to 9,000 sf	36"	NA (1)	164	0.5	0.5	NA (1)	2.2	NA (1)	1.9
	48"	NA (1)	89	0.5	0.5	NA (1)	2.9	NA (1)	1.9
	60"	NA (1)	55	0.5	0.5	NA (1)	3.6	NA (1)	1.7
9,001 to 9,500 sf(2)	36"	NA (1)	174	0.5	0.5	NA (1)	2.2	NA (1)	2.1
	48"	NA (1)	94	0.5	0.5	NA (1)	2.9	NA (1)	2.0
	60"	NA (1)	58	0.5	0.5	NA (1)	3.7	NA (1)	1.7

Notes:

- Minimum Requirement #7 (Flow Control) is required when the 100-year flow frequency causes a 0.15 cubic feet per second increase (when modeled in WWHM with a 15-minute timestep). Breakpoints shown in this table are based on a flat slope (0-5%). The 100-year flow frequency will need to be evaluated on a site-specific basis for projects on moderate (5-15%) or steep (> 15%) slopes.
- Soil type to be determined by geotechnical analysis or soil map.
- Sizing includes a Volume Correction Factor of 120%.
- Upper bound contributing area used for sizing.

(1) On Type B soils, new plus replaced impervious surface areas exceeding 8,500 sf trigger Minimum Requirement #7 (Flow Control)

(2) On Type C soils, new plus replaced impervious surface areas exceeding 9,500 sf trigger Minimum Requirement #7 (Flow Control)

(3) Minimum orifice diameter = 0.5 inches

in = inch
ft = feet
sf = square feet

Basis of Sizing Assumptions:

Sized per MR#5 in the Stormwater Management Manual for Puget Sound Basin (1992 Ecology Manual)
SBUH, Type 1A, 24-hour hydrograph
2-year, 24-hour storm = 2 in; 10-year, 24-hour storm = 3 in; 100-year, 24-hour storm = 4 in
Predeveloped = second growth forest (CN = 72 for Type B soils, CN = 81 for Type C soils)
Developed = impervious (CN = 98)
0.5 foot of sediment storage in detention pipe
Overland slope = 5%

Appendix C

MAINTENANCE & OPERATIONS MANUAL

Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(5) Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Top slab is free of holes and cracks. Frame is sitting flush on the riser rings or top slab and firmly attached.

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Appendix D
GEOTECHNICAL ENGINERING STUDY

PanGEO
INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

April 16, 2019
File No. 19-062.100

Mr. Benjamin C. Altman, Exe.,
The Estate of James Altman, Sr.
Attn: George Steirer, Plan to Permit, LLC.
10365 El Honcho Place
San Diego, CA 92124-1219

Subject: **Geotechnical Engineering Study**
Proposed Development
6423 East Mercer Way
Mercer Island, WA

Dear Mr. Altman,

As requested, PanGEO, Inc. has completed a geotechnical engineering study to assist you and your project team with the design and construction of your proposed Development at the above-address. This study was performed in general accordance with our mutually agreed scope of work outlined in our proposal dated February 8, 2019, which you subsequently authorized on February 16, 2019. Our service scope included reviewing readily-available geology maps for the project vicinity, reviewing preliminary design plans, drilling eight test borings, conducting a site reconnaissance, and developing the conclusions and recommendations presented in this report.

SITE AND PROJECT DESCRIPTION

For reference, the address of 6423 East Mercer Way is used. The site at this address is currently developed with a single-family residence built in 1968. The properties for the proposed development are located on separate and individual lots around the reference property, and have a combined area of 35,522 square feet (see Figures 1 and 2). All properties are owned by the estate of James Altman, Sr. The ground surface in the vicinity of all the lots generally slopes down to the east and south with up to 60 feet of elevation relief. The south facing slope descends to E. Mercer Way and is especially steep.

3213 Eastlake Avenue East Suite B
Seattle, WA 98102-7127
Tel (206) 262-0370
Fax (206) 262-0374

The easternmost, 15,812 sq. ft. parcel (302405-9151) is located above the 90-degree bend in E. Mercer Way (see Figures 2 and 3a). Moderately steep slopes surround the property to the south and west, forming a semi-open bowl with about 30 feet of total relief. The surface within the bowl is relatively level, and the near 90-degree angle between the south and west slopes suggest the site has been excavated. Preliminary plans call for developing the bowl portion of the property (see Figure 2).

Parcel 302405-9001 (see Figures 2 and 3b) is located north of the property at 6423 E. Mercer Way, between the reference property and SE 64th Street. The site slopes generally steeply to the east and south, and the southwestern portion of the property is traversed by a moderately sloping, east facing ridge. A prominent drainage swale occupies the northeastern part of the site. A steep slope, up to 1H:1V, divides SE 64th Street from the main level of the property. Preliminary plans call for the development of the ridge crest and upper swale portion of the property (see Fig. 2).

The parcel (#302405-9213) located at 9167 SE 64th Street is also irregularly shaped, undeveloped, and 18,635 sq. feet in size (see Figures 2 and 3c). The property slopes moderately to steeply to the south, with nearly 60 feet of relief down to East Mercer Way. There is a moderately sloping bench area at about elevation 170 feet, which is about 20 feet below SE 64th Street. Preliminary plans call for the development of the area above the bench (see Figure 2).

All the properties are mapped within a landslide hazard area by the City of Mercer island. As such, any development will need to consider the steep slopes and landslide hazards. We understand that while plans are conceptual in nature, but that you wish a “comprehensive” geotechnical study to consider the issues of geological hazards, and to support permitting efforts going forward for all parcels.

The conclusions and recommendations outlined in this report are based on our understanding of the proposed development, which is in turn based on the project information provided. If the above project description is incorrect, or the project information changes, we should be consulted to review the recommendations contained in this study and make modifications, if needed.

SUBSURFACE EXPLORATIONS

Subsurface conditions at the site were explored with eight borings (PG-1 to PG-8) which were drilled at the locations shown on Figure 1. Three of the new borings were drilled on Parcel

302405-9151, and four of the new borings were drilled on Parcel 302405-9001. No previous exploration had been done on these two parcels. One new boring was drilled on parcel 3024059213 to supplement existing subsurface information from previously drilled borings on the property (AMEC Earth & Environmental, Inc., 2001). The new explorations were advanced on March 7, 19 and 21, 2019, using an EC-95 track mounted drill and a hand-operated portable Acker drill rig, both owned and operated by Boretec, Inc., of Spangle, Washington. The new borings were drilled to depths of 11.5 to 41.5 feet below the existing ground surface.

Soil samples were obtained from the borings at 2½-foot and 5-foot depth intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples were obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven 18-inches into the soil using a 140-pound weight freely falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist from our office was present to observe the drilling, assist in sampling, and to describe and document the soil samples obtained from the borings. The soil samples were described and field classified in general accordance with ASTM D 2488-00, following the guidelines of the Unified Soil Classification System. Summary logs of the new borings are included in Appendix A. The logs of two borings by AMEC used in this study are also included in Appendix A.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

SITE GEOLOGY

Based on the Geologic Map of Mercer Island (Troost and Wisher, 2006), the predominant near surface soil unit on the property consists of mass wasting deposits from past slope movements. The mass wasting deposits are described as loose to dense or soft to stiff, colluvium, landslide debris and soil with indistinct morphology. Locally, organic material may be found in the mass wasting deposits. The surficial mass wasting deposits between SE 64th Street and East Mercer Way are mapped as underlain mainly by Lawton Clay Deposits (Qvlc), with some Pre-Olympia Nonglacial Deposits (Qpon) near East Mercer Way. Lawton Clay deposits are described as very stiff to hard silt, silty clay and clayey silt, laminated to massive. Pre-Olympia Nonglacial deposits are described as very dense or hard, sand, gravel, silt, clay and organic beds.

SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

The soils observed in the borings consisted of interbedded sand and silty clay deposits, with silty clay occurring near the top of the slope and sand underneath the clay and lower down on the slope. Most of the borings encountered colluvium near the surface, consisting of locally derived native material that has been disturbed by slope or mass wasting processes. Fill was found only in PG-2 near the foot of the slope. In general, the deposits found on the site do not resemble Lawton Clay deposits as mapped, and in our opinion the project area is underlain almost entirely by pre-Olympia strata.

The following describes the soils encountered in the borings. Please refer to the boring logs (Figures 4 to 11) for more detailed descriptions:

> ***UNIT 1: Fill***– Fill was observed in PG-2 on off the main driveway access to the homes just off East Mercer Way. The fill consisted of 5½ feet of loose, brown, silty, fine SAND. The fill contained occasional organics and exhibited a mixed texture. As indicated above, the hollow on Parcel 302405-9151 appears to have been excavated, and we anticipate that this was the source of the fill, which was used to fill a shallow stream drainage to provide access to the house at 6423 E Mercer Way and one other house. The fill soil in PG-1 was underlain by 4 feet of red brown, silty, fine SAND, which was lumped in with the fill based on N-value, but which may be alluvial in nature.
>
> ***UNIT 2: Colluvium*** – The borings near the top of the slope, PG-6, PG-7 and PG-8 encountered a layer of disturbed soil at the surface. The colluvium was identified by low N-values and mixed textures. In PG-6 on Parcel 302405-9001, sited just below SE 64th Street, the colluvium consisted of two layers, a three-foot thick layer of loose, brown, silty, fine to coarse SAND at the surface, underlain by a 2½-foot thick layer of loose, brown, clayey SILT with fine sand. Both layers contained occasional gravel. PG-8 was located below PG-6 near the top of the east facing drainage swale on Parcel 302405-9001. This boring encountered a 4½ feet of loose or stiff, brown, silty CLAY to clayey SILT. The soil is slightly to low plastic, with some layers showing rapid dilatancy. In PG-7 on the property at 9167 SE 64th Street, the colluvium consisted of 4½ feet of loose,

yellow brown SILT with fine sand, underlain by 4½ feet of medium dense, silty, fine SAND to sandy SILT on this property. This lower unit may be a bed of advanced outwash, but was interpreted as colluvium based on the low N-values. The AMEC borings (B-4 and B-5) also encountered colluvium consisting of soft to medium stiff clayey SILT to sandy SILT, to a depth of roughly 15 and 11 feet, respectively.

UNIT 3: pre-Olympia Silty Clay Deposits – Beds consisting mainly of silty, lean CLAY, with beds of non-plastic to slightly plastic clayey SILT, were found from the surface in PG-3, PG-4 and PG-5, and beneath the colluvium in PG-6 to PG-8. PG-3 was drilled just below the driveway to 6423 E Mercer Way, and penetrated 8 feet of medium dense, non-plastic, brown gray SILT. PG-4 and PG-5 on Parcel 302405-9151, both penetrated 9 ½ feet very stiff to hard, brown gray, low plastic, silty, lean CLAY. The clay was laminated and the strata appeared to be dipping at angles of 5 to 25 degrees. In PG-4 the thick silty clay was underlain by 2½ feet of thinly interbedded clayey silt and silty, fine sand, possibly a transitional unit. Below the colluvium in PG-6 the boring encountered 5 feet of dense, brown, slightly plastic, clayey SILT with some fine sand, followed by 10 feet of very stiff to hard, brown, low plastic, silty, lean CLAY. PG-8 penetrated interbedded stiff to hard brown to brown gray, low plastic, silty, lean CLAY and slightly plastic, medium dense to very dense, clayey SILT with fine sand. At depth in PG-7 we found stiff to very stiff, gray, silty, lean CLAY.

UNIT 4: pre-Olympia Sand Deposits – Sand beds were encountered at the ground surface (PG-1) or at depth in all borings except PG-7 and PG-8. Where encountered at depth (PG-4 to PG-6), the sand strata consisted of beds of medium dense to very dense, brown to brown gray, silty, fine SAND or fine to medium SAND.

Groundwater was encountered in PG-2, PG-7 and PG-8. Groundwater was not found in PG-1, PG-3, or PG-4 to PG-6. The groundwater in PG-1 is presumed to be flow along the filled in drainage swale. In PG 7 and PG-8 the groundwater is perched in the shallow colluvial deposits above less permeable clay deposits. Borings B-4 and B-5 encountered groundwater at 9 and 8 feet below surface, respectively. Groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring.

GEOLOGY HAZARDS ASSESSMENT

Landslide Hazards and Steep Slopes

According to the City of Mercer Island's Geologic Hazards Map, the site lies within a potential landslide hazard area where landslides have occurred in the past. Based on our field observations and the results of our field exploration, it is our opinion that the site is globally stable in its current configuration. It is also our opinion that the planned constructions will not adversely impact the overall stability of the subject and surrounding properties, provided that the recommendations presented in this report are properly incorporated into the design and construction of the project.

Erosion Hazards

The site also lies within a mapped potential erosion hazard area. Based on the results of our test borings, the silty and clayey site soils of upper portion of the site are anticipated to exhibit moderate to low erosion potential. The sand soils may pose a moderate to high risk of erosion,. In our opinion, the erosion hazard at the site can be effectively mitigated with the best management practice during construction and with properly designed and implemented landscaping for permanent erosion control. During construction, the temporary erosion hazard can be effectively managed with an appropriate erosion and sediment control plan, including but not limited to installing silt fencing at the construction perimeter, limiting removal of vegetation from the construction area, placing rocks or hay bales at the disturbed/traffic areas and on the downhill side of the project, covering all stockpiled soil or cut slopes with plastic sheets, constructing a temporary drainage pond to control surface runoff and sediment traps if needed, placing rocks at the construction entrance, etc. Permanent erosion control measures should include establishing vegetation, landscape plants, and hardscape established at the end of project.

Seismic Hazards

The site also lies with a mapped potential seismic hazard area, which may be susceptible to risk of damage from earthquake-induced ground shaking, slope failure, soil liquefaction, or surface faulting. While the site is contained within the area mapped as having a known or suspected seismic hazard, the relative lack of groundwater and the cohesive soils in the two eastern parcels suggest the hazard is not high or moderate. The parcel at 9167 SE 64th Street may have a moderate potential for liquefaction, which may be by supporting any structure on driven pin pile foundations. Potential remedial measures are subsequently discussed in the engineering design recommendations.

GEOTECHNICAL DESIGN RECOMMENDATIONS

SEISMIC DESIGN PARAMETERS

The following provides seismic design parameters for the site that are in conformance with the 2012 International Building Code (IBC), which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps:

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters	
	S_S	S_1	F_a	F_v	S_{DS}	S_{D1}
D	1.449	0.554	1.0	1.5	0.996	0.554

HOUSE FOUNDATIONS

In general, the houses may be supported on conventional spread footings and/or driven pin piles. Parcel 302405-9151 may be supported on spread footings where located over dense sand in hillside cuts, but the loose sand fill area will require pin piles. Parcel 302405-9001 may be founded on spread footings in the ridge area around PG-4 and PG-5, but may require pin piles if the house extends into the swale around PG-8. Pin pile foundations should be used to support the house at 9167 SE 64th Street to mitigate potential settlement due to the loose surficial soils. The following presents our recommendations for spread footings and pin pile foundations.

Conventional Foundations

Based on results of our test borings, dense soil is anticipated to be present at the foundation level in portions of parcels 302405-9151 and 302405-9001. How much of any proposed structures may be placed on spread footings depends on the final footprint and location of the structure on the property.

Allowable Bearing Pressure

We recommend using an allowable soil bearing pressure of 3,000 pounds per square feet (psf) be used for footings bearing on dense to very dense, native pre-Olympia sand or clay deposits, or compacted fill. The recommended allowable bearing pressures are for dead plus live loads. For allowable stress design, the recommended bearing pressure may be increased by one-third for transient loading, such as wind or seismic forces. Continuous and individual spread footings should have minimum widths of 18 and 24 inches, respectively. Footings should be placed at least 18 inches below final exterior grade. Interior footings should be placed at least 12 inches below the top of slab.

Foundation Performance

Total and differential settlements are anticipated to be within tolerable limits for foundation designed and constructed as discussed above. Conventional footings bearing on competent native soil and structural fill may experience static settlement of less one inch and differential settlement between adjacent columns should be less than about ½ inch. Most settlement should occur during construction as loads are applied.

Lateral Resistance

Lateral forces from wind or seismic loading may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and walls, and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pounds per cubic foot (pcf). This value includes a factor safety of at least 1.5 assuming that densely compacted structural fill will be placed adjacent to the sides of the foundation. A friction coefficient of 0.4 may be used to determine the frictional resistance at the base of the foundation. This coefficient includes a factor of safety of approximate 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

Footing Subgrade Preparation

All footing subgrades should be carefully prepared. The adequacy of footing subgrade should be verified by a representative of PanGEO, prior to placing forms or rebar. The footing subgrade should be in a dense condition prior to concrete pour. Any footing over-excavations should be backfilled with Seattle Type 2 or 17 material, which should be placed in 8-inch thick lifts and compacted to a dense condition. Footing excavations should be observed by PanGEO to confirm that the exposed footing subgrade is consistent with the expected conditions and adequate to support the design bearing pressure.

It should be noted that site soils are highly moisture sensitive and can be easily disturbed when exposed to moisture. If footings are constructed during wet weather, the exposed footing subgrade should be adequate protected to prevent disturbance. The footing subgrade may be protected with at least 3 inches of lean-mix concrete, or 4 to 6 inches of compacted crushed surfacing base course (CSBC).

Pin Pile Foundations

We recommend pin pile foundation support for any structure constructed on the 9167 SE 64th Street parcel, and for portions of the other two parcels including the fill area of parcel 302405-9151 and the upper swale area of 302405-9001. Pile parameters are as follows:

***Pin Pile Sizes* -** In our opinion, 3-, 4-, or 6-inch diameter, Schedule 40, galvanized, steel pipes (pin piles) may be used to support the new structure. Three, four, and six-inch diameter pin piles are typically installed using small hammers mounted on a small excavator.

***Pin Pile Capacity* -** The number of piles required depends on the magnitude of the design load. Allowable axial compression capacities of 6, 10, and 15 tons may be used for the 3-, 4-, and 6-inch diameter pin piles, respectively, with an approximate factor of safety of 2 for piles driven to refusal. Penetration resistance required to achieve the (refusal) capacities will be determined based on the hammer used to install the pile. Tensile capacity of pin piles should be ignored in design calculations.

It is our experience that the driven pipe pile foundations should provide adequate support with total settlements on the order of ½-inch or less.

The criterion for driving refusal is defined as the minimum amount of time (in seconds) required to achieve one inch of penetration, and it varies with the size of hammer used for pile driving. For 3-, 4-, and 6-inch pin piles, the following table is a summary of driving refusal criteria for different hammer sizes that are commonly used:

Summary of Commonly-Accepted Driving Criteria for 3-, 4-, and 6-inch Pin Pile with a 6, 10, and 15-ton Allowable Axial Compression Load

Hammer Model	Hammer Weight (lb) / Blows per minute	3" Pile Refusal Criteria (seconds per inch of penetration)	4" Pile Refusal Criteria (seconds per inch of penetration)	6" Pile Refusal Criteria (seconds per inch of penetration)
Hydraulic TB 325	850 / 900	10	16	
Hydraulic TB 425	1,100 / 900	6	10	20
Hydraulic TB 725X	2,000 / 600	3	4	10
Hydraulic TB 830X	3,000 / 500			6

Please note that these refusal criteria were established empirically based on previous load tests on 3-, 4-, and 6-inch pin piles. Contractors may select a different hammer for driving these piles, and propose a different driving criterion. In this case, it is the contractor's responsibility to demonstrate to the Engineer's satisfaction that the design load can be achieved based on their selected equipment and driving criteria.

Pin Pile Specifications - We recommend that the following specifications be included on the foundation plan:

1. All piles should consist of galvanized Schedule-40, ASTM A-53 Grade "A" pipe.
2. All piles shall be driven to refusal (see above table).
3. Piles shall be driven in nominal sections and connected with compression fitted sleeve couplers (i.e. no welding of pipe segments).
4. The geotechnical engineer of record or his/her representative shall observe pin pile installation.

The quality of a pin pile foundation is dependent, in part, on the experience and professionalism of the installation company. We recommend that a company with experienced personnel be selected to install the piles.

Lateral Forces - The capacity of pin pipes to resist lateral loads is very limited and should not be used in design. Therefore, lateral forces from wind or seismic loading should be resisted by the passive earth pressures acting against the pile caps and below-grade walls or from battered piles (batter no steeper than 3(H):12(V)). ***Friction at the base of pile-supported concrete grade beam should be ignored in the design calculations.*** Passive resistance values may be determined using an equivalent fluid weight of 400 pounds per cubic foot (pcf). This value includes a safety factor of about 1.5 assuming that properly compacted granular fill will be placed adjacent to and surrounding the pile caps and grade beams.

Grade Beam/Pile Cap Embedment - We recommend that the base of perimeter grade beams extend at least 18 inches below the adjacent exterior ground surface and that the base of interior grade beams extend at least 12 inches below interior floor slabs.

Estimated Pile Length – The subsurface conditions at the site will likely vary substantially across the site. Based on the soil conditions at the site and our experience in the project area, for planning and cost estimating purposes, we estimate that pile length may range from about 10 to 20 feet.

PERIMETER FOOTING DRAIN AND INTERCEPTOR TRENCH DRAIN

Perimeter drains should be installed around buildings at or just below the invert of the footing or pile caps. Under no circumstances should roof downspout drain lines be connected to the footing drain systems. Roof downspouts must be separately tightlined to appropriate discharge locations. Cleanouts should be installed at strategic locations to allow for periodic maintenance of the footing drain and downspout tightline systems.

CONCRETE SLAB-ON-GRADE

In our opinion, conventional slab-on-grade construction may be utilized for the floor slabs. All soil beneath the floor slabs should be compacted to a dense and unyielding condition prior to placing capillary break material for the floor slabs. On-site soils that cannot be compacted to a dense and unyielding condition should be removed and replaced with compacted structural fill.

Slab-on-grade floors should be underlain by a capillary break consisting of at least of 4 inches of ¾-inch, clean crushed rock (less than 3 percent fines) compacted to a firm and unyielding condition. The capillary break should be placed on subgrade that has been compacted to a dense and unyielding condition. The capillary break should be placed on a suitable subgrade as confirmed by PanGEO. A 10-mil polyethylene vapor barrier should also be placed directly below the slab. We also recommend that control joints be incorporated into the floor slab to control cracking.

RETAINING AND BASEMENT WALL DESIGN PARAMETERS

Retaining and basement walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided behind the walls to intercept and remove groundwater that may be present behind the wall. Our geotechnical recommendations for the design and construction of the retaining/below-grade walls are presented below.

Lateral Earth Pressures

Concrete cantilever walls should be designed for an active pressure of 35 pcf for level backfills behind the walls assuming the walls are free to rotate or for an equivalent fluid weight of 50 pcf for rigid or unyielding walls. Walls with a 1(H):1(V) backslope should be designed for an active equivalent fluid weight of 45 pcf. Permanent walls should be designed for an additional uniform lateral pressure of 6H psf for seismic loading, where H corresponds to the buried depth of the wall. These recommendations assume that the wall backfill will consist of a free draining and properly compacted fill with adequate drainage provisions.

Surcharge

Surcharge loads, where present, should also be included in the design of retaining walls. We recommend that a lateral load coefficient of 0.3 be used to compute the lateral pressure on the wall face resulting from surcharge loads located within a horizontal distance of one-half wall height.

Lateral Resistance

Lateral forces from seismic loading and unbalanced lateral earth pressures may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and by friction acting on the base of the footings. Passive resistance values may be determined using an equivalent fluid weight of 400 pcf. This value includes a factor of safety of 1.5, assuming the footing is poured against dense native sand, re-compacted on-site sandy soil or properly compacted structural fill adjacent to the sides of footing. A friction coefficient of 0.5 may be used to determine the frictional resistance at the base of the footings. The coefficient includes a factor safety of 1.5.

Wall Drainage

Provisions for wall drainage should consist of a 4-inch diameter perforated drainpipe behind and at the base of the wall footings, embedded in 12 to 18 inches of clean crushed rock and pea gravel wrapped with a layer of filter fabric. We recommend a composite drainage material, such as Miradrain 6000, be used for drainage on exterior walls. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

Wall Backfill

In our opinion, imported structural fill should be used for wall backfill, and should consist of granular material, such as WSDOT Gravel Borrow or approved equivalent. In areas where the space is limited between the wall and the face of excavation clean crushed rock may be used as backfill without compaction.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. Within 5 feet of the wall, the backfill should be compacted with hand-operated equipment to at least 90 percent of the maximum dry density.

PARCEL 30214059001 ACCESS

Preliminary concept for driveway access to the parcel 30214059001 indicates a plan to construct a driveway from SE64th Street, as shown on Figure 2. This would require traversing a slope that is up to 1H:1V in places, especially at the top, and the slope is designated a steep slope hazard by the City of Mercer Island. In our opinion, the proposed driveway would require a soldier pile wall for support, would have a gradient of some 25 percent, and have poor sight distances with

SE64th Street. Construction would require an easement from the New Hope Church to cross a portion of their property, and also an easement from the City of Mercer Island. Existing overhead utilities would have to be temporarily relocated.

Alternatively, a partially developed pathway may be used for access along the north property line of the house at 6423 E Mercer Way and enters the property along the ridgeline from the southeast. This alignment could be developed into a driveway relatively easily and would have a gradient of roughly 10 to 12 percent.

From above, a driveway access could be developed beginning at the northwest corner of the property at 9185 SE 64th Street and trending east across the slope to enter the subject property at the northwest corner. This alignment would require permanent easements from the New Hope Church and from property owner of 9185 SE 64th Street. However, the driveway cut starts 10 to 12 feet below the start elevation of the preliminary alignment, and construction could take advantage of a naturally occurring bench on the hillside.

CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

Site preparation for the proposed project mainly includes site clearing and excavations to the design subgrade. All debris resulted from site clearing should be hauled away from the site. The stripped surface soil materials should be properly disposed off-site or be “wasted” on site in non-structural landscaping areas.

Following site clearing and excavations, the adequacy of the subgrade should be verified by a representative of PanGEO. Areas of weak soil may require over-excavation and replacement with compacted structural fill or lean-mix concrete.

TEMPORARY EXCAVATIONS

Planning for the individual sites is not well advanced, so the depth of excavations, if any, is currently unknown. We anticipate most excavations will mainly encounter loose to medium dense silty sand and soft silt and/or clay. All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring.

Based on anticipated soil conditions temporary excavations may be sloped at 1(H):1(V). However, the temporary excavations and cut slopes should be re-evaluated in the field during construction and may require modifications in the wet season. The cut slopes should be covered with plastic sheets in the wet season. We also recommend that heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a distance equal to 1/3 the slope height from the top of any excavation.

PERMANENT CUT AND FILL SLOPES

Based on the soil conditions underlying the site, we recommend permanent cut and fill slopes be constructed no steeper than 2(H):1(V).

MATERIAL REUSE

In the context of this report, structural fill is defined as compacted fill placed under footings, concrete stairs and landings, and slabs, or other load-bearing areas. In our opinion, the on-site soil is not suitable as structural fill. The structural fill should consist of imported, well-grade, granular material, such as WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent. The on-site fill may be used as general fill in the non-structural and landscaping areas. If use of the on-site soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent softening from rainfall in the wet season.

STRUCTURAL FILL PLACEMENT AND COMPACTION

Structural fill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557.

Depending on the type of compaction equipment used and depending on the type of fill material, it may be necessary to decrease the thickness of each lift to achieve adequate compaction. PanGEO can provide additional recommendations regarding structural fill and compaction during construction.

WET WEATHER EARTHWORK

In our opinion, the construction at the proposed sites may be accomplished during wet weather without adversely affecting the site stability. However, earthwork construction performed during the drier summer months will likely be more economical. The properties underlain by pre-Olympia fines grained deposits could become especially difficult should the clay soils become disturbed and saturated. Winter construction will require the implementation of best management erosion and sedimentation control practices to reduce the risk of off-site sediment transport. Most of the site soils within the anticipated depth of excavation contain a high percentage of fines and are moisture sensitive. Any footing subgrade soils that become softened either by disturbance, groundwater or rainfall should be removed and replaced with structural fill, Controlled Density Fill (CDF), or lean-mix concrete.

General recommendations relative to earthwork performed in wet conditions are presented below:

- Site stripping, excavation and subgrade preparation should be followed promptly by the placement and compaction of clean structural fill or CDF;
- The size and type of construction equipment used may have to be limited to prevent soil disturbance;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Geotextile silt fences and bales of straw should be strategically located to control erosion and the movement of soil;
- Structural fill should consist of less than 5% fines; and
- Excavation slopes should be covered with plastic sheets.

SURFACE DRAINAGE CONSIDERATIONS

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area from leaving the immediate work site.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from slopes and structures. Water from roof drains and other impervious areas should be properly collected and discharged into a storm drain system, and should not be discharged on to the slope areas.

ADDITIONAL SERVICES

To confirm that our recommendations are properly incorporated into the design and construction of the proposed development, PanGEO should be retained to conduct a review of the final project plans and specifications, and to monitor the construction of geotechnical elements. The City of Mercer Island, as part of the permitting process, will also require geotechnical construction inspection services. PanGEO can provide you a cost estimate for construction monitoring services at a later date.

We anticipate that the following additional services will be required:

- Review final project plans and specifications
- Verify implementation of erosion control measures;
- Verify adequacy of footing subgrade;
- Monitor pin pile installation;
- Monitor temporary excavation;
- Monitor the installation of temporary and permanent soldier pile walls
- Verify the adequacy of subsurface drainage installation;
- Confirm the adequacy of the compaction of structural backfill; and
- Other consultation as may be required during construction

Modifications to our recommendations presented in this report may be necessary, based on the actual conditions encountered during construction.

CLOSURE

We have prepared this report for Benjamin C. Altman, Exe., George Steirer and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,

400
STEPHEN H. EVANS
Stephen H. Evans

W. PAUL GRANT
20099
W. P. Grant

Stephen H. Evans, L.E.G.
Senior Engineering Geologist

W. Paul Grant, P.E.
Principal Geotechnical Engineer

Enclosures:

Figure 1: Vicinity Map

Figure 2: Project Overview and Boring Locations

Figure 3a: Site and Exploration Plan, Lot 302405-9151

Figure 3b: Site and Exploration Plan, Lot 302405-9001

Figure 3c: Site and Exploration Plan, Lot 302405-9213 (9167 SE 64th Street)

Appendix A: PanGEO and AMEC Boring Logs

REFERENCES

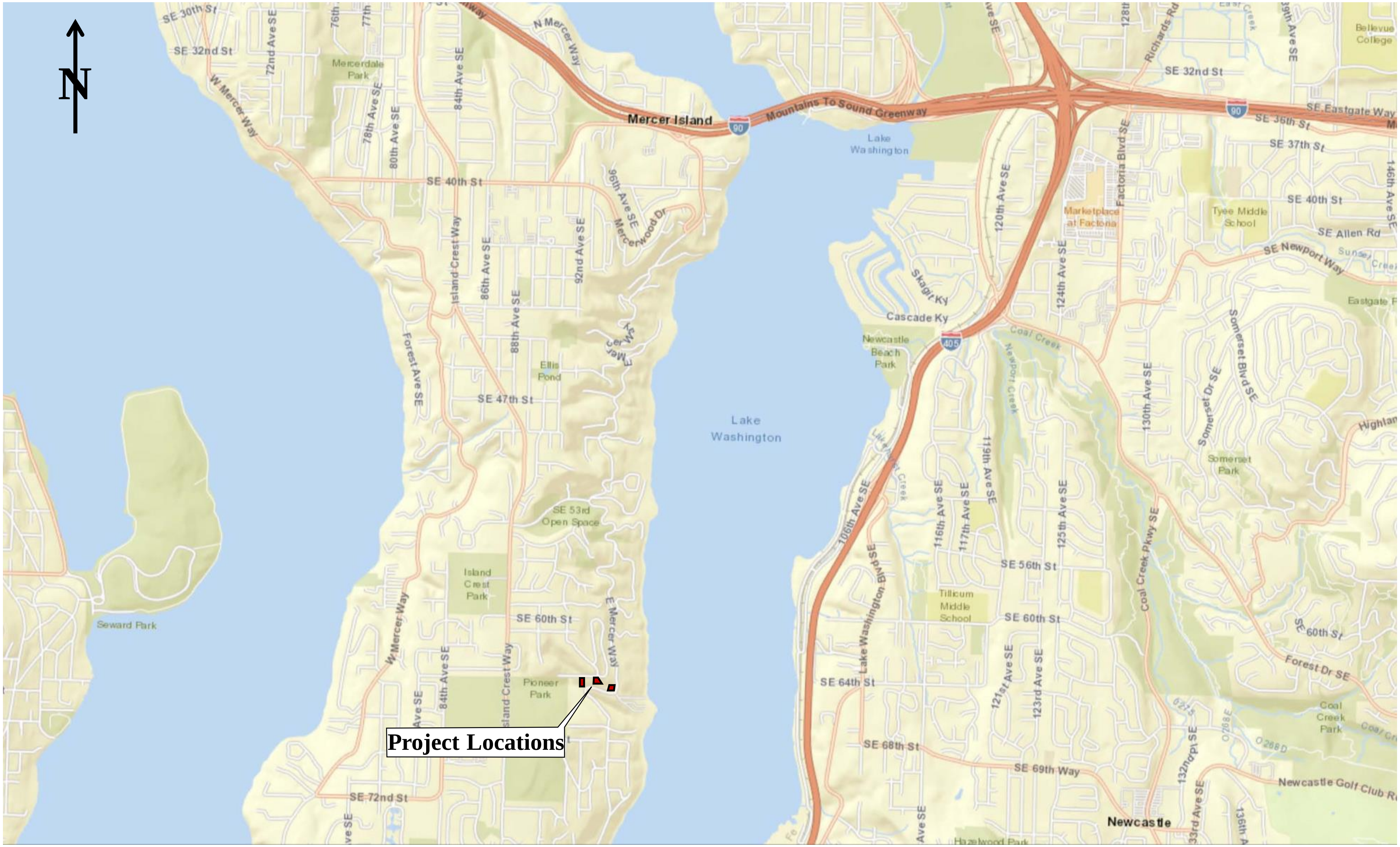
AMEC Earth & Environmental, July 3, 2001, *Geotechnical Engineering Report, Proposed Single Family Residence, 46xx S.E. 64th Street, Mercer Island, Washington,* a report for JDW Homes, LLC, 4740 E. Mercer Way, Mercer Island, Washington.

International Code Council, 2015, *International Building Code (IBC).*

Troost, K.G., and Wisher, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:24,000*.

WSDOT, 2018, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10.*

19-062 Vicinity Fig 1.ppt 5/17/2019(10:16 AM) SHE



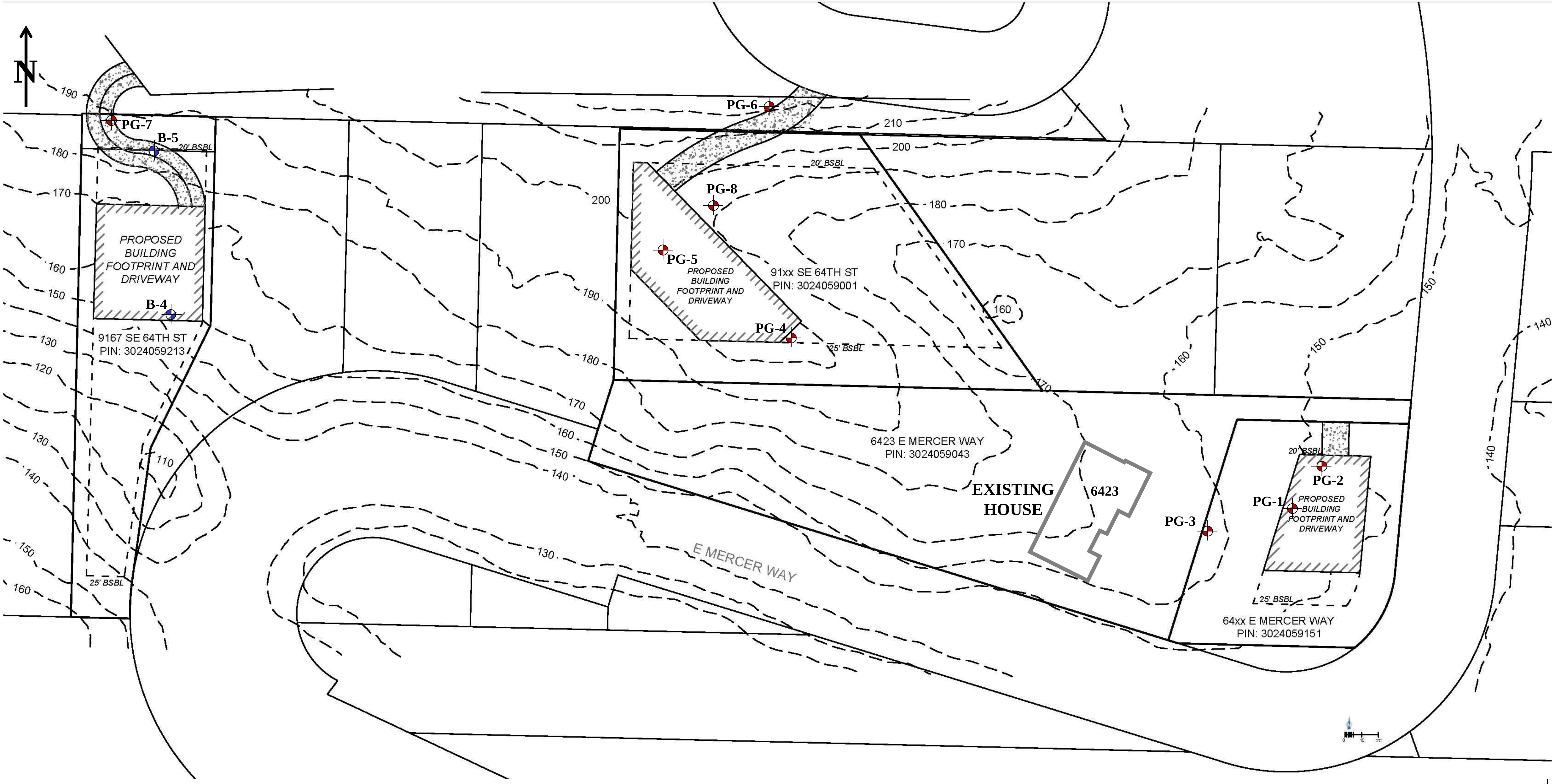
Map not to Scale
Base Map from
Dept of Natural
Resources Geological
Information Portal

PanGEO
INCORPORATED

Proposed Development
6423 East Mercer Way
Mercer Island, WA

VICINITY MAP

Project No.	Figure No.
19-062	1



Not to Scale

Legend:

- 🔴 **PanGEO Boring**
- 🔵 **AMEC Boring**

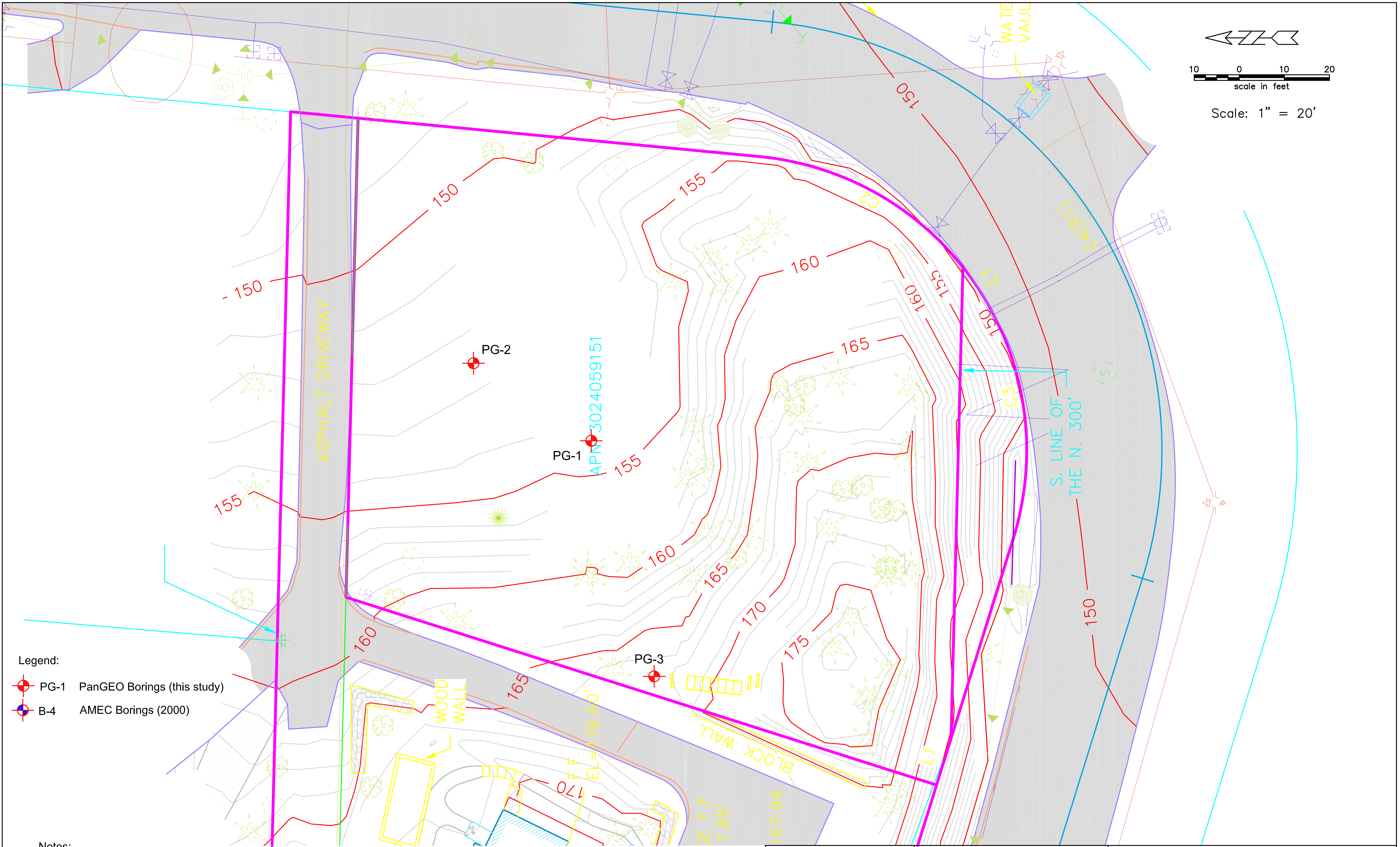
PanGEO INCORPORATED

Proposed Development
6423 E Mercer Way
Mercer Island, WA

PROJECT OVERVIEW AND BORING LOCATIONS

Project No. 19-062

Figure No. 2



Legend:

🔴	PG-1	PanGEO Borings (this study)
🔵	B-4	AMEC Borings (2000)

Notes:

1. Base map provided by Plan to Permit, May, 2019. Elevations are based on the NAVD88 datum.
2. Boring logs for PanGEO borings PG-1 through PG-8 are located in Appendix A. Locations for these borings are approximate and based on the relative locations of known site features.
3. Boring logs for historic investigations are located in Appendix B.

PanGEO
INCORPORATED

Proposed 3-Lot Development
6423 East Mercer Way
Mercer Island, Washington

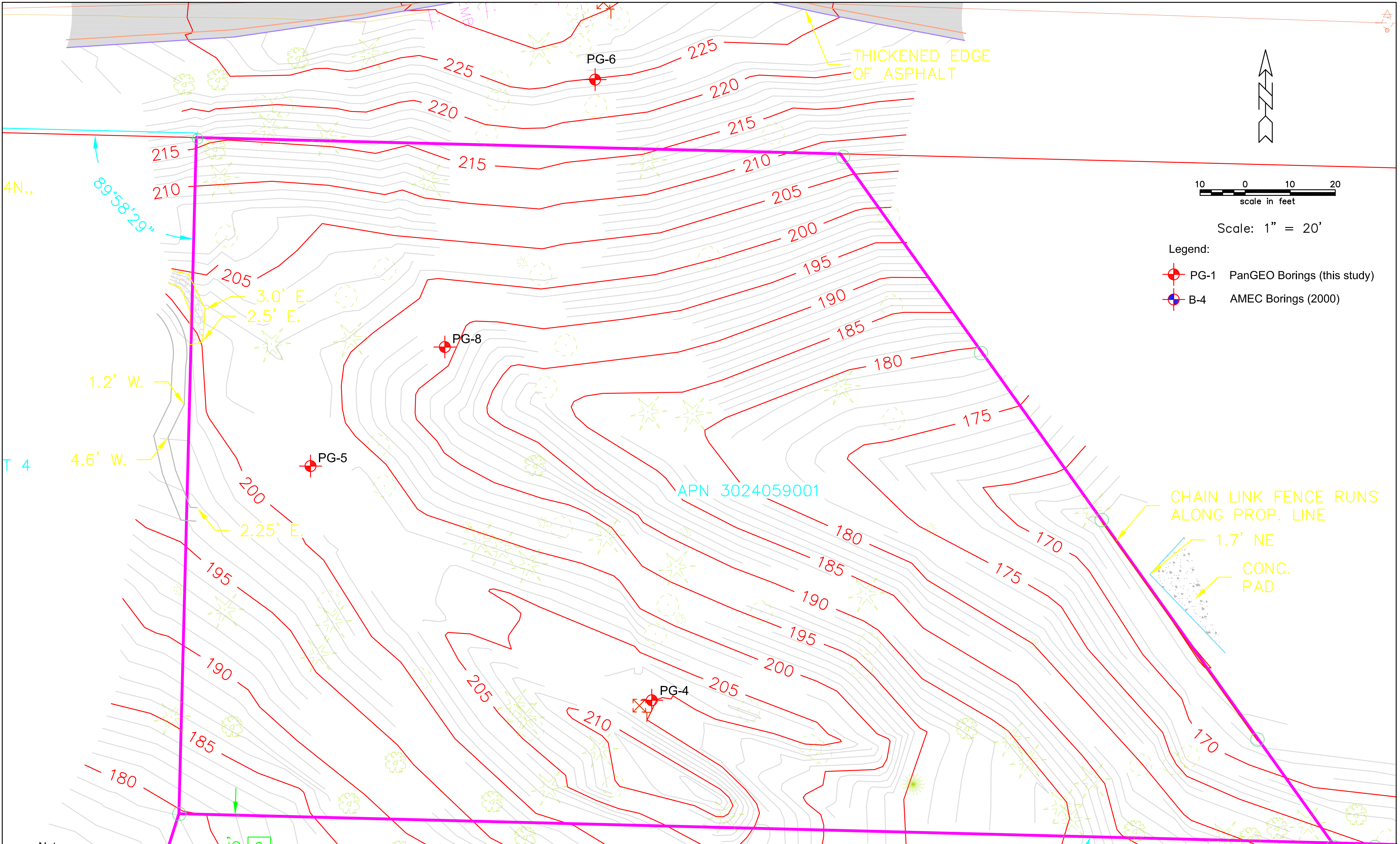
SITE AND EXPLORATION PLAN
LOT 3024059151

PROJECT NO. 19-063

FIGURE NO. 3a

Z:/Projects/2019 Projects/19-062/Exploration/Plant-190204_19-2-25_2013

DRAWN BY: SHE
CHECKED BY: WPG
DATE: 05.09.19



Notes:

1. Base map provided by Plan to Permit, May, 2019. Elevations are based on the NAVD88 datum.
2. Boring logs for PanGEO borings PG-1 through PG-8 are located in Appendix A. Locations for these borings are approximate and based on the relative locations of known site features.
3. Boring logs for historic investigations are located in Appendix B.

PanGEO
INCORPORATED

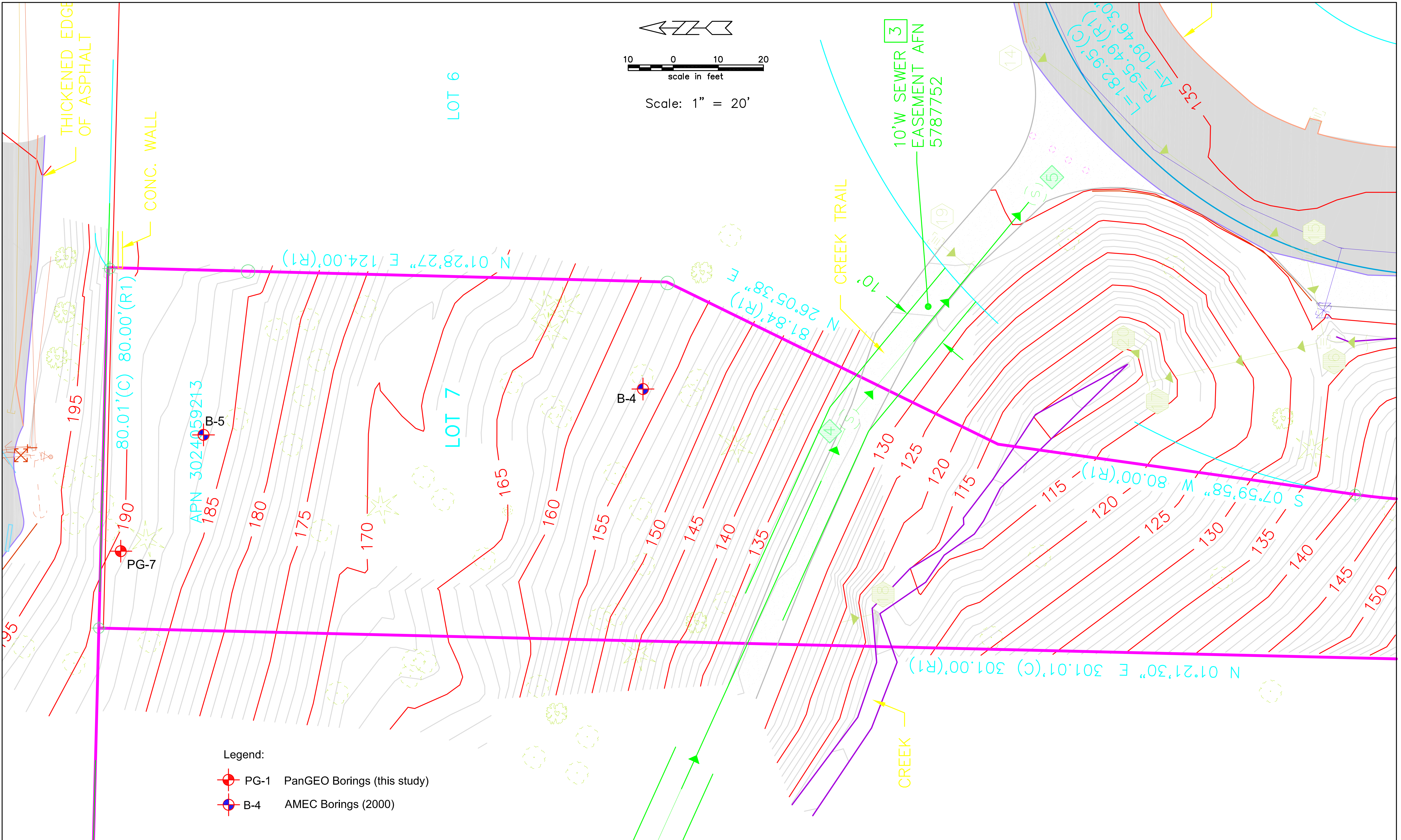
Proposed 3-Lot Development
6423 East Mercer Way
Mercer Island, Washington

SITE AND EXPLORATION PLAN
LOT 3024059001

PROJECT NO. 19-063

FIGURE NO. 3b

DRAWN BY: SHE CHECKED BY: WPG DATE: 05.09.19 Z:/Projects/2019 Projects/19-062/Exploration/Plant-190204_19-2-25_2013



Legend:

PG-1	PanGEO Borings (this study)
B-4	AMEC Borings (2000)

Notes:

1. Base map provided by Plan to Permit, May, 2019. Elevations are based on the NAVD88 datum.
2. Boring logs for PanGEO borings PG-1 through PG-8 are located in Appendix A. Locations for these borings are approximate and based on the relative locations of known site features.
3. Boring logs for historic investigations are located in Appendix B.

PanGEO
INCORPORATED

Proposed 3-Lot Development
6423 East Mercer Way
Mercer Island, Washington

SITE AND EXPLORATION PLAN
LOT 3024059213

PROJECT NO. 19-063

FIGURE NO. 3c

Z:/Projects/2019 Projects/19-062/Exploration/Plant-190204_19-2-25_2013

DATE: 05.09.19

CHECKED BY: WPG

DRAWN BY: SHE

APPENDIX A

SUMMARY TEST BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS		
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	●	GW	Well-graded GRAVEL
		○	GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	○	GM	Silty GRAVEL
		▨	GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	░	SW	Well-graded SAND
		░	SP	Poorly-graded SAND
	SAND (>12% fines)	░	SM	Silty SAND
		▨	SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	▥	ML	SILT
		▨	CL	Lean CLAY
		☰	OL	Organic SILT or CLAY
	Liquid Limit > 50	▥	MH	Elastic SILT
		▨	CH	Fat CLAY
		≋	OH	Organic SILT or CLAY
Highly Organic Soils		⁂	PT	PEAT

Notes:

1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered:	Units of material distinguished by color and/or composition from material units above and below	**Fissured:**	Breaks along defined planes
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm	**Slickensided:**	Fracture planes that are polished or glossy
Lens:	Layer of soil that pinches out laterally	**Blocky:**	Angular soil lumps that resist breakdown
Interlayered:	Alternating layers of differing soil material	**Disrupted:**	Soil that is broken and mixed
Pocket:	Erratic, discontinuous deposit of limited extent	**Scattered:**	Less than one per foot
Homogeneous:	Soil with uniform color and composition throughout	**Numerous:**	More than one per foot
		BCN:	Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	**Sand**	
Cobbles:	3 to 12 inches	**Coarse Sand:**	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		**Medium Sand:**	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	**Fine Sand:**	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	**Silt**	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

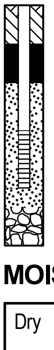
Sample/In Situ test types and intervals

⊠	2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
⧗	3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
▚	Non-standard penetration test (see boring log for details)
■	Thin wall (Shelby) tube
✋	Grab
▮	Rock core
◫	Vane Shear

MONITORING WELL

∇ Groundwater Level at time of drilling (ATD)

▼ Static Groundwater Level



MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

PanGEO
INCORPORATED
Phone: 206.262.0370

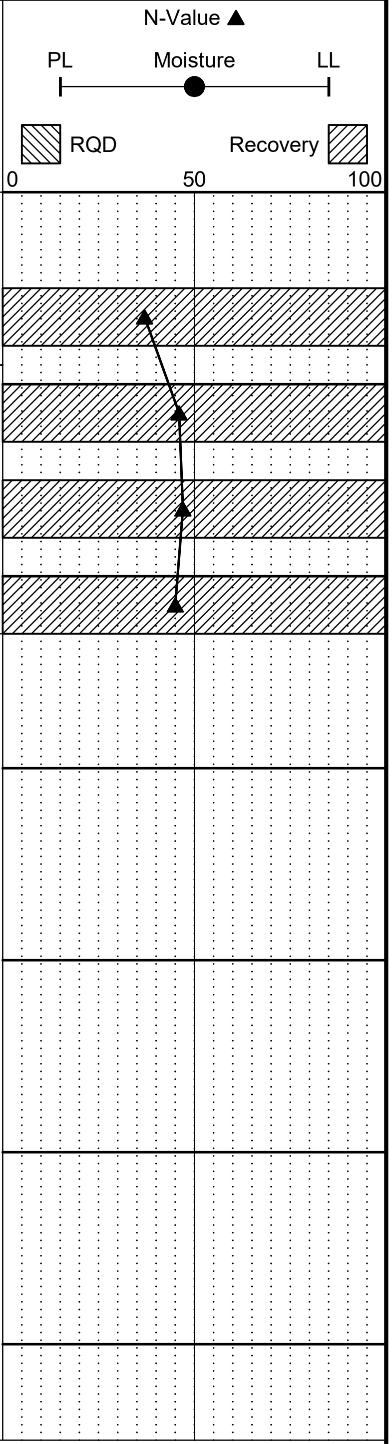
Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Dense, brown, silty, fine SAND: slightly moist, non-plastic fines, homogeneous, laminated with slightly rusty laminae. (pre-Olympia Sand Deposit).
	S-1	☒	11 17 20			
5	S-2	☒	13 20 26			Dense, grown to brown gray, fine to medium SAND: slightly moist, some silt, homogeneous, laminated. (pre-Olympia Sand Deposit).
	S-3	☒	16 22 25			
10	S-4	☒	12 23 22			
						Bottom of Boring.
15						
20						
25						
30						



Completion Depth: 11.5ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO INCORPORATED

LOG OF TEST BORING PG-1

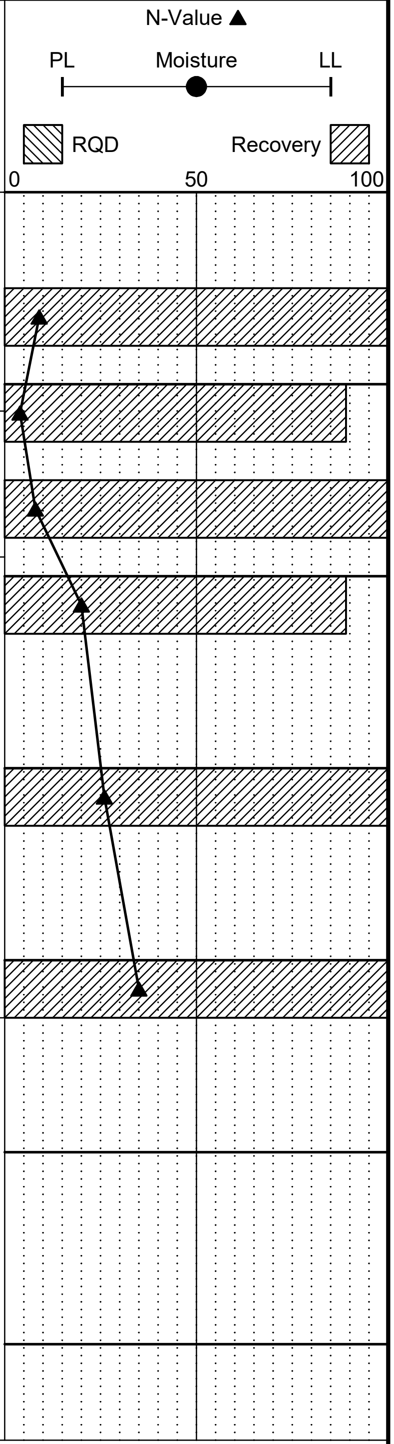
Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Loose, brown, silty, fine SAND: moist, non-plastic fines, occasional organic bits, slightly mixed texture. (Fill).
	S-1	☒	5 4 5			
5	S-2	☒	3 1 3			Loose, red brown, silty, fine SAND with silt: moist to very moist, non-plastic fines, homogeneous, massive. (Fill/Alluvium).
	S-3	☒	4 4 4			Laminated, grading brown with reddish laminae.
10	S-4	☒	5 8 12			Medium dense to dense, brown to brown gray, fine to medium SAND with silt: very moist to wet, non-plastic fines, homogeneous, laminated with slightly rusty laminae at top. (pre-Olympia Sand Deposit).
					∇	
15	S-5	☒	9 12 14			Wet, non-plastic fines, rapid dilatancy, laminated with many yellowish laminae.
20	S-6	☒	13 16 19			Massive.
						Bottom of Boring.
25						
30						



Completion Depth: 21.5ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: Groundwater level estimated based on wetness of soil sample and water on the sampling rods.

PanGEO INCORPORATED

LOG OF TEST BORING PG-2

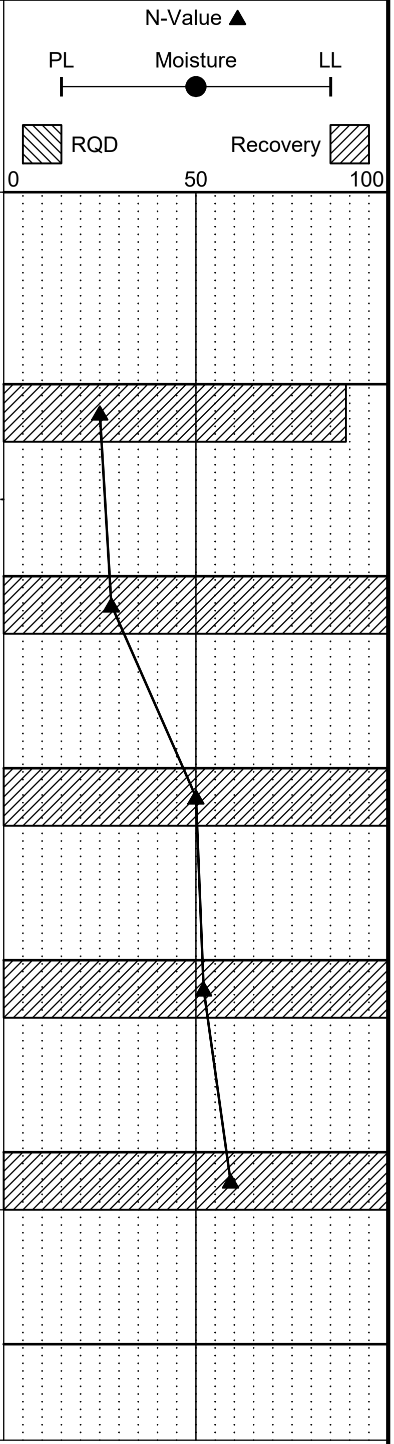
Figure A-3

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Medium dense, brown gray SILT: very moist, non-plastic, trace to some fine sand, homogenous, laminated. (pre-Olympia Silty Clay Deposit).
5	S-1	☒	6 10 15			Grading to silty, fine SAND.
						Medium dense to very dense, brown to brown gray, fine to medium SAND: moist, non-plastic fines, fine bedded with finer / coarse beds, sharp and moderately gradational contacts, indistinctly laminated. (pre-Olympia Sand Deposit).
10	S-2	☒	8 12 16			
15	S-3	☒	14 25 25			Grading massive, very dense, some non-plastic silt.
20	S-4	☒	15 24 28			Homogeneous, massive, fine to medium SAND.
25	S-5	☒	18 29 30			Moist, trace to some silt.
						Bottom of Boring.
30						



Completion Depth: 26.5ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO
INCORPORATED

LOG OF TEST BORING PG-3

Figure A-4

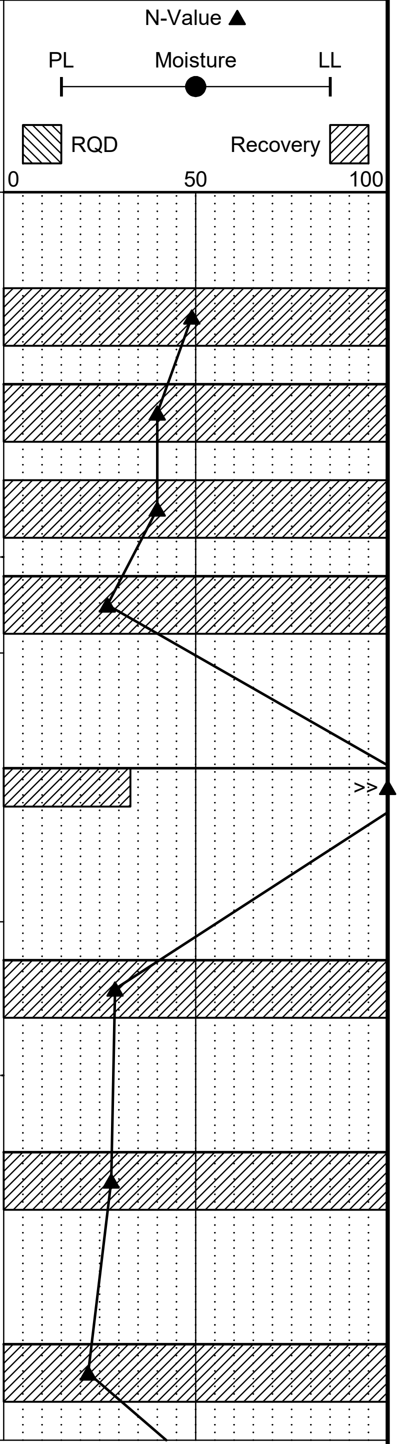
The stratification lines represent approximate boundaries. The transition may be gradual.

Sheet 1 of 1

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0					▨	Hard, brown gray, silty, lean CLAY: slightly moist, low plastic, homogeneous, laminated, occasional slightly rusty laminae, dip ~ 10°. (pre-Olympia Silty Clay Deposit).
	S-1	☒	10 21 28		▨	
5	S-2	☒	10 19 21		▨	Low plastic, slow dilatancy, light brown laminae and partings, splits easily on bedded, dips to ~ 20°.
	S-3	☒	14 17 23		▨	Laminated, dips to 25°, planar fracture cutting across bedding at 60°, occasional fine organic grains and non-plastic silt laminae.
10	S-4	☒	6 13 14		░	Medium dense or very stiff, brown gray, interbedded clayey SILT and silty, fine SAND:slightly moist, slightly to low plastic and non-plastic, moderately sharp contacts, dips to 20°. (pre-Olympia Mixed Deposit).
					░	Dense, brown gray, silty, fine SAND with gravel: slightly moist, gravel subrounded, blocky and tabular, non-plastic fines, homogeneous, gravelly beds especially, massive. (pre-Olympia Sand Deposit).
15	S-5	☒	16 50/6		░	
					░	Medium dense, brown, fine to medium SAND with silt: slightly moist, non-plastic fines, homogeneous, laminated with occasional clayey silt interbed, dips to 10°. (pre-Olympia Sand Deposit).
20	S-6	☒	10 13 16		░	
					░	Medium dense, brown gray, silty, fine SAND: slightly moist, non-plastic fines, grading to sandy silt in some layers, homogeneous, indistinctly laminated with dips to 5°. (pre-Olympia Sand Deposit).
25	S-7	☒	12 14 14		░	
30	S-8	☒	9 10 12		░	Sub-horizontal laminae, slightly rusty laminae.



Completion Depth: 41.5ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO
INCORPORATED

LOG OF TEST BORING PG-4

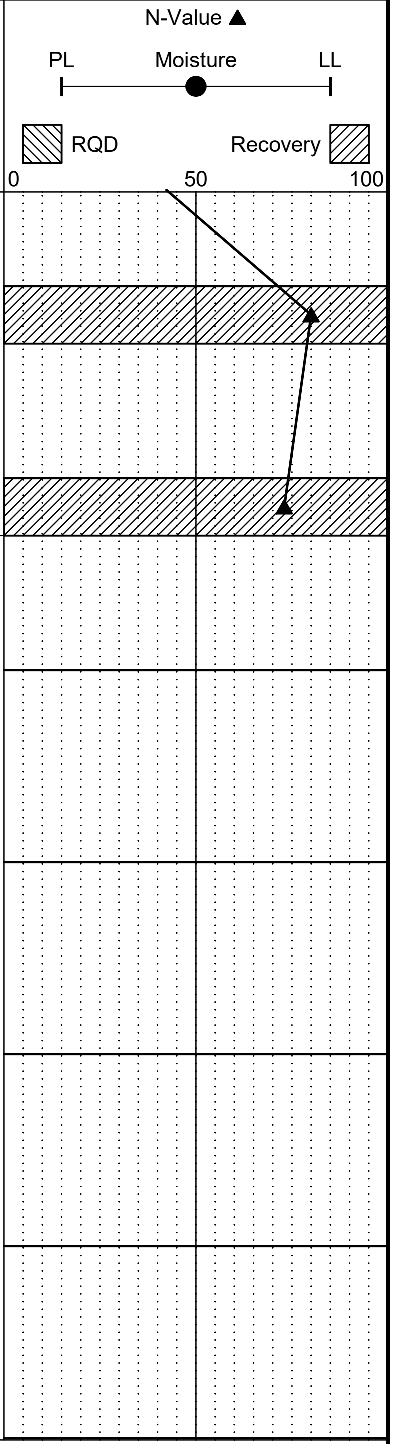
Figure A-5

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
						Medium dense, brown gray, silty, fine SAND: slightly moist, non-plastic fines, grading to sandy silt in some layers, homogeneous, indistinctly laminated with dips to 5°. (pre-Olympia Sand Deposit). *(Continued)*
35	S-9	☒	19 37 43			Becoming very dense, rare rusty pocket.
40	S-10	☒	19 34 39			Indistinctly laminated to massive.
						Bottom of Boring.
45						
50						
55						
60						
65						



Completion Depth: 41.5ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO
INCORPORATED

LOG OF TEST BORING PG-4

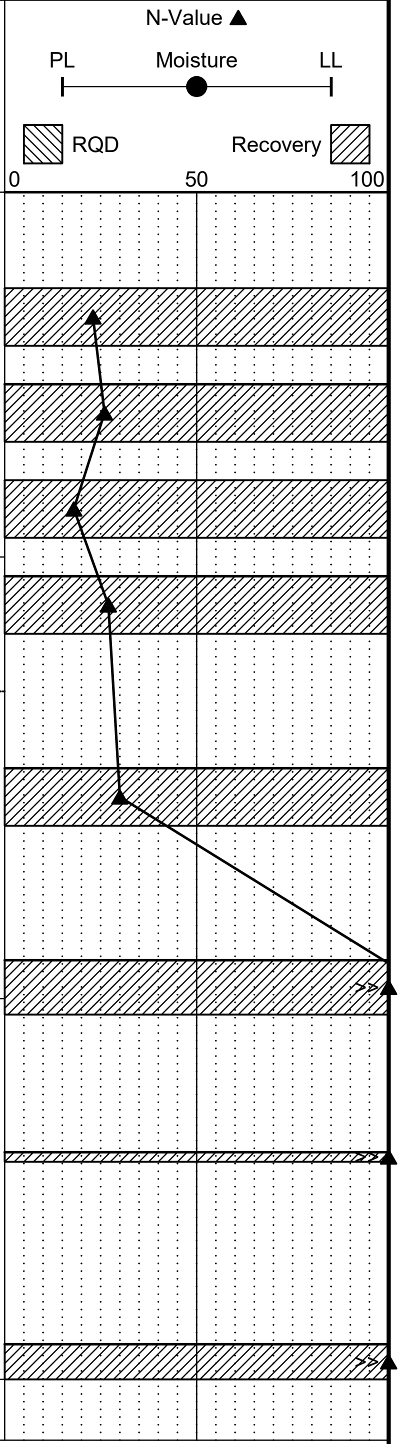
Figure A-5

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Very stiff, brown gray, silty, lean CLAY: moist, low plastic, homogenous, laminated with occasional rusty laminae, dips to 5°. (pre-Olympia Silty Clay Deposit).
	S-1	☒	5 10 13			
5	S-2	☒	7 12 14			Occasional organic bits, rusty laminae, dips 5 to 7°.
	S-3	☒	7 8 10			Occasional non-plastic silt bed, one hard, waxy gray clay bed, occasional rip-up clast, rusty veins.
10	S-4	☒	10 13 14			Medium dense, brown gray, clayey SILT: slightly moist, slightly plastic, homogeneous, laminated with rusty partings and pockets, occasional organic bits, dips to 5°. (pre-Olympia Silty Clay Deposit).
						Dense or hard, brown gray, interbedded, silty, fine SAND and silty, lean CLAY: slightly moist, non-plastic and low plastic beds, occasional rusty zones, fine bedded (4 to 6 inches), indistinctly laminated. (pre-Olympia Silty Clay Deposit).
15	S-5	☒	8 14 16			
20	S-6	☒	14 43 50/5			Grading to clayey SIlt, slightly to low plastic, massive, occasional rusty vein.
						Very dense, brown gray, fine to coarse SAND; slightly moist, trace to some silt, massive, weathered gravel at upper contact. (pre-Olympia Sand Deposit).
25	S-7	☒	50/3			Grading to fine to medium SAND.
30	S-8	☒	35 50/5			Homogeneous, indistinctly laminated to massive.
						Bottom of Boring.



Completion Depth: 30.9ft
Date Borehole Started: 3/7/19
Date Borehole Completed: 3/7/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO INCORPORATED

LOG OF TEST BORING PG-5

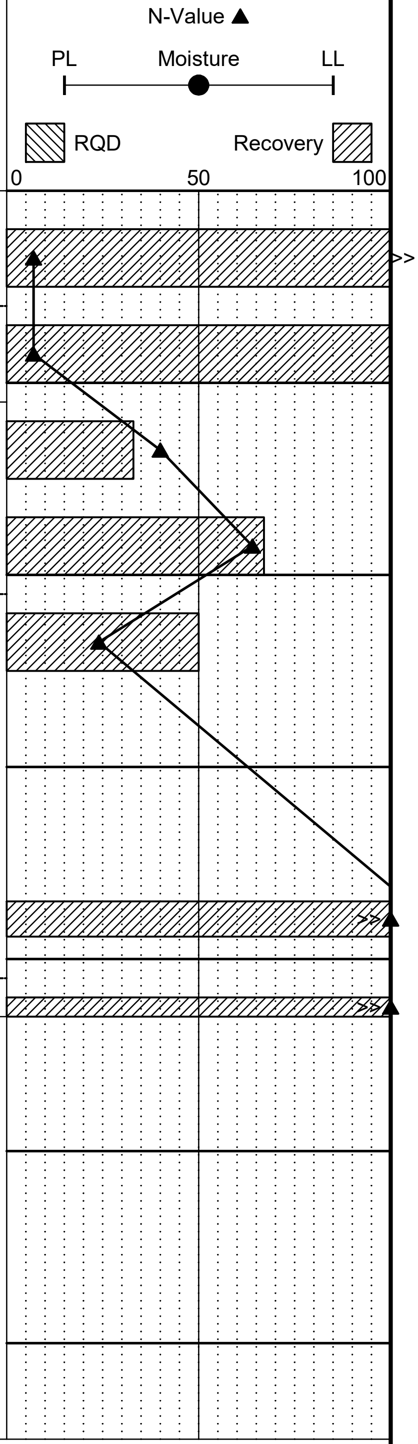
Figure A-6

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	Proposed Lot Development	Surface Elevation:	
Job Number:	19-062	Top of Casing Elev.:	
Location:	6423 East Mercer Way, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1	☒	3 3 4			Loose, brown, silty, fine to coarse SAND: moist, slightly plastic fines, occasional gravel, mixed texture. (colluvium).
5	S-2	☒	3 3 4			Loose, brown, clayey SILT with fine sand: moist, slightly plastic fines with rapid dilatancy, homogeneous, occasional gravel, massive. (Colluvium).
	S-3	☒	11 19 21			Dense / hard, clayey SILT: slightly moist, slightly to low plastic, some fine sand, occasional gravel, homogeneous, massive. (pre-Olympia Silty Clay Deposit.
10	S-4	☒	24 32 32			With fine sand, possible organic laminae, trace fine rusty mottles, laminated.
	S-5	☒	12 9 15			Very stiff, brown, silty, lean CLAY: slightly moist, low plastic, homogeneous, laminated with wavy and lighter/darker laminae. (pre-Olympia Silty Clay Deposit).
15						
	S-6	☒	22 50/5			Grading silty, lean CLAY to clayey SILT, possible fine organic bits.
20	S-7	☒	50/6			Very dense, brown gray, silty, fine to medium SAND: slightly moist, non-plastic fines, homogeneous, some gravel, massive. (pre-Olympia Silty Clay Deposit).
25						
30						

Bottom of Boring.



Completion Depth:	21.5ft
Date Borehole Started:	3/19/19
Date Borehole Completed:	3/21/19
Logged By:	S. Evans
Drilling Company:	Boretec, Inc

Remarks: No groundwater encountered during drilling.

PanGEO INCORPORATED

LOG OF TEST BORING PG-6

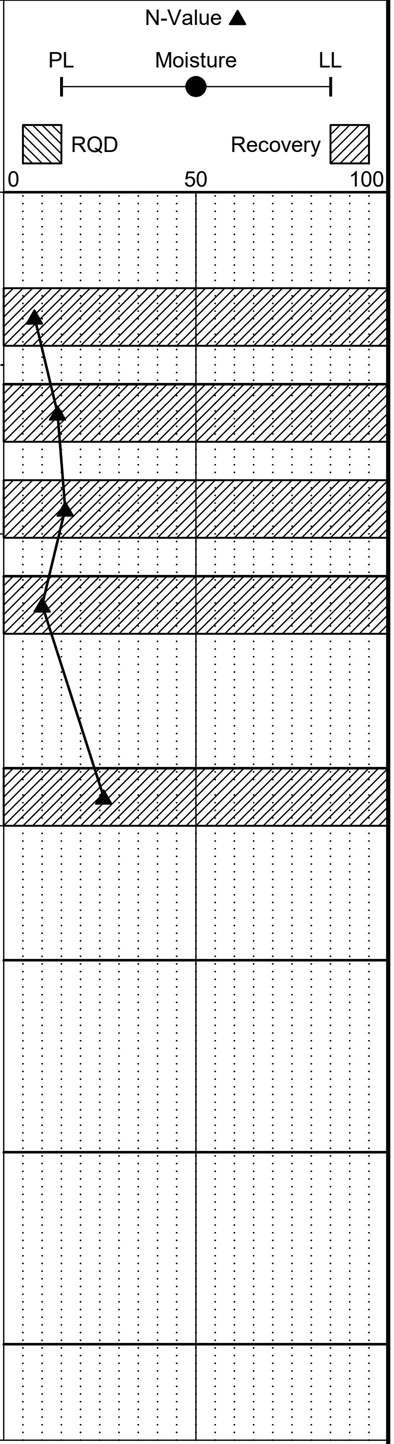
Figure A-7

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Loose, yellow brown SILT with fine sand: moist, non-plastic with rapic dilatancy, homogenous, occasional rusty pockets, laminated. (Colluvium).
	S-1	☒	3 4 4			
5	S-2	☒	4 6 8			Medium dense, brown gray, silty,fine SAND to sandy SILT: very moist with wet zones, non-plastic with rapid dilatancy, homogeneous, laminated, wood at top. (Colluvium).
					∇	Occasional rusty laminae, abundant fine sparkles - qtz?.
	S-3	☒	6 7 9			
						Medium stiff to very stiff, silty, lean CLAY: very moist, low plastic, no dilatancy, homogeneous, scattered rusty pockets, indistinctly laminated, rare blady organic. (pre-Olympia Silty Clay Deposit).
10	S-4	☒	5 5 5			
15	S-5	☒	9 12 14			
						Bottom of Boring.
20						
25						
30						



Completion Depth: 16.5ft
Date Borehole Started: 3/21/19
Date Borehole Completed: 3/21/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: Groundwater level estimated based on wetness of soil sample and water on the sampling rods.

PanGEO INCORPORATED

LOG OF TEST BORING PG-7

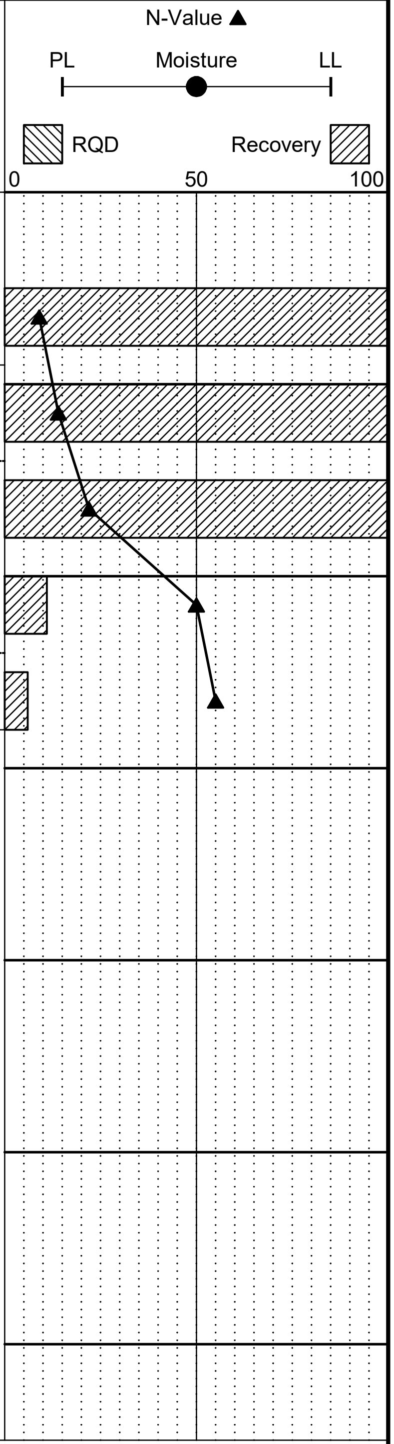
Figure A-8

The stratification lines represent approximate boundaries. The transition may be gradual.

Project: Proposed Lot Development
Job Number: 19-062
Location: 6423 East Mercer Way, Mercer Island, WA
Coordinates: Northing: , Easting:

Surface Elevation:
Top of Casing Elev.:
Drilling Method: HSA
Sampling Method: SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0						Loose / Stiff, brown, clayey SILT to silty CLAY: wet, slightly to low plastic layers, some layers with rapid dilatancy, faint rusty mottles, occasional gravel, massive. (Colluvium).
	S-1	☒	2 3 6			
5	S-2	☒	4 6 8			Stiff, brown, silty, lean CLAY: very moist to wet, low plastic, homogeneous, faint reddish stains, laminated, occasional fine gravel, possible organic clast. (pre-Olympia Silty Clay Deposit).
	S-3	☒	7 8 14			Medium dense to very dense, brown gray, clayey SILT with fine sand: very moist, slightly plastic, homogeneous, occasional rusty bands, massive to indistinctly laminated. (pre-Olympia Silty Clay Deposit).
10	S-4	☒	12 20 30			Becoming moist, very dense.
	S-5	☒	31 28 27			Hard / Very dense, brown gray, clayey SIL to silty, lean CLAY: moist, some fine sand, low to slightly plastic, homogeneous, occasional fine gravel, massive. (pre-Olympia Silty Clay Deposit).
						Bottom of Boring.
15						
20						
25						
30						



Completion Depth: 14.0ft
Date Borehole Started: 3/21/19
Date Borehole Completed: 3/21/19
Logged By: S. Evans
Drilling Company: Boretec, Inc

Remarks: Groundwater level estimated based on wetness of soil sample and water on the sampling rods.

PanGEO INCORPORATED

LOG OF TEST BORING PG-8

Figure A-9

The stratification lines represent approximate boundaries. The transition may be gradual.

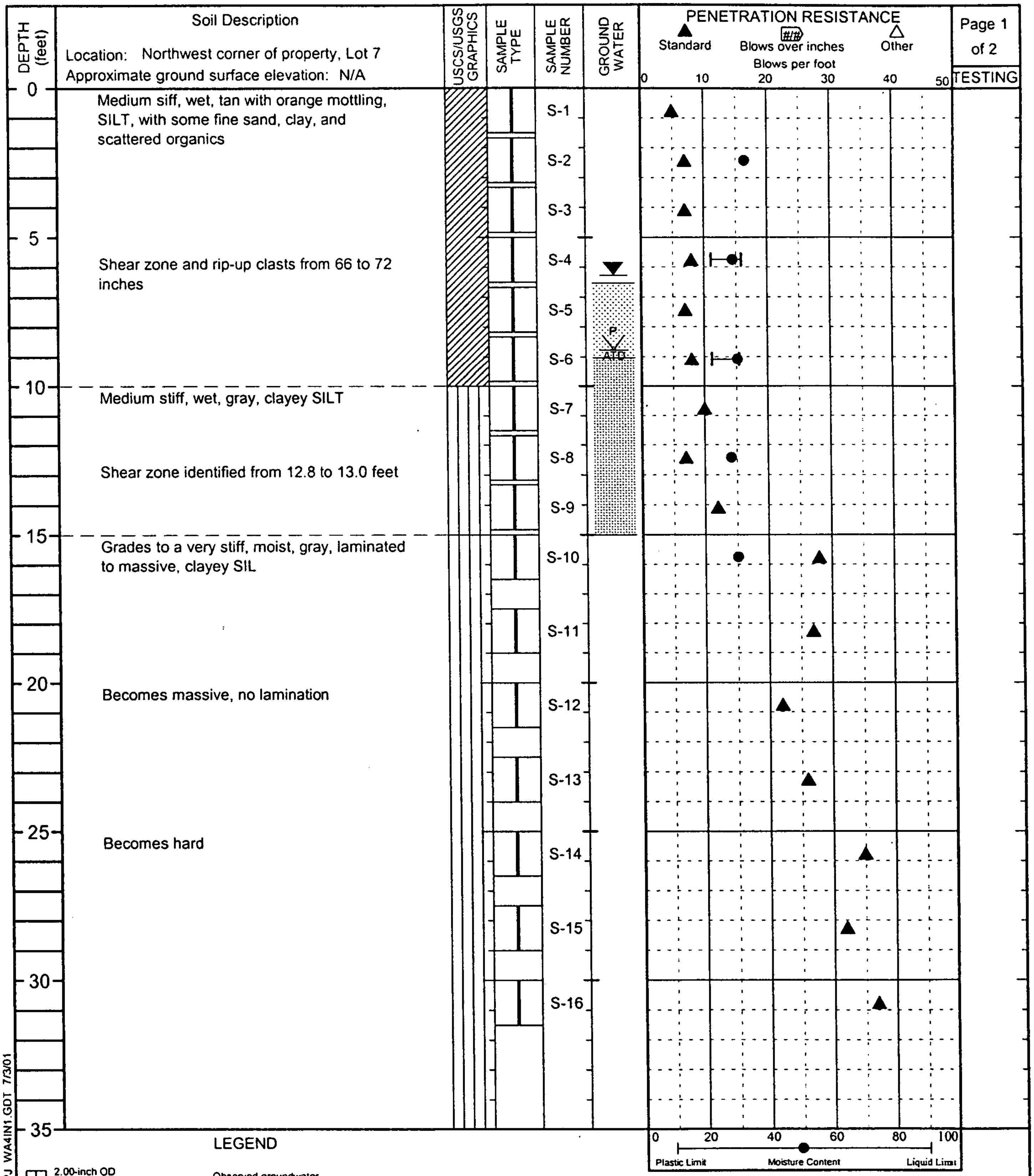
PROJECT: *Mercer Island Short Plat* W.O. *0-91M-13513-0* BORING No. *B-4*

Soil Description

Location: Northwest corner of property, Lot 7

Approximate ground surface elevation: N/A

Page 1 of 2



Medium siff, wet, tan with orange mottling, SILT, with some fine sand, clay, and scattered organics

Shear zone and rip-up clasts from 66 to 72 inches

Medium stiff, wet, gray, clayey SILT

Shear zone identified from 12.8 to 13.0 feet

Grades to a very stiff, moist, gray, laminated to massive, clayey SIL

Becomes massive, no lamination

Becomes hard

LEGEND

◫	2.00-inch OD split-spoon sampler
▼	Observed groundwater level
P ATD	Perched water level at time of drilling

Figure A-10

amec
11335 N.E. 122nd Way Suite 100
Kirkland, Washington 98034-6913

4IN1 MERCER.GPJ WA4IN1.GDT 7/3/01

Drilling Method: HSA Hammer type: Automatic Date drilled: *March 27, 2000* Logged By: *KSS*

PROJECT: *Mercer Island Short Plat* W.O. *0-91M-13513-0* BORING No. *B-4*

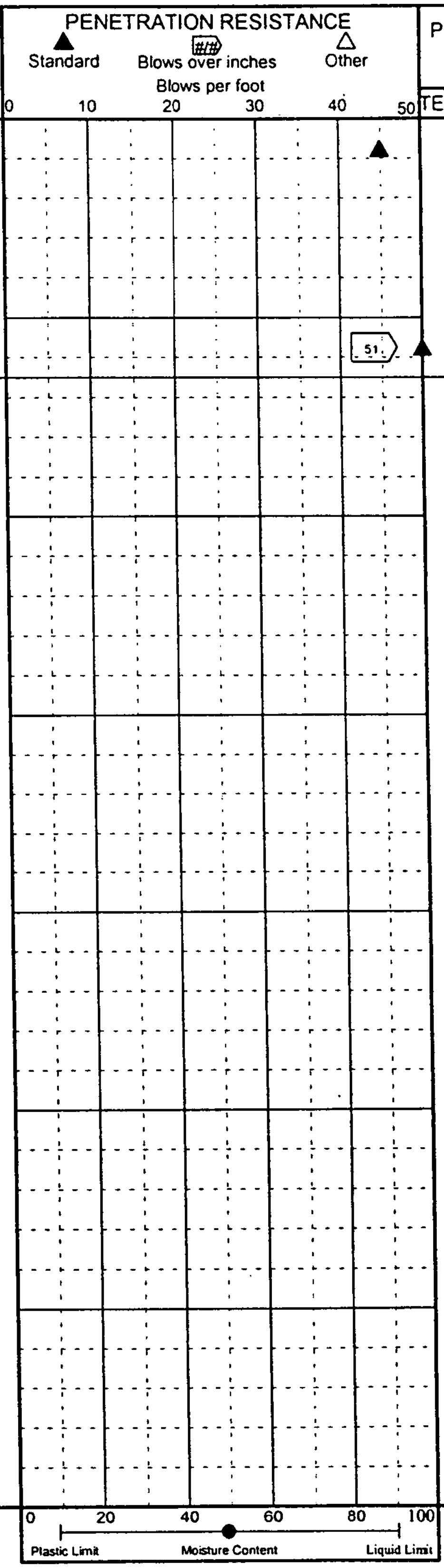
Page 2 of 2

Soil Description

Location: Northwest corner of property, Lot 7

Approximate ground surface elevation: N/A

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
35	Hard, moist, gray, massive clayey SILT (as above)			S-17		
40				S-18		
45	Boring terminated at approximately 41.5 feet					
50						
55						
60						
65						
70						



LEGEND

▯ 2.00-inch OD split-spoon sampler

▼ Observed groundwater level

P ATD Perched water level at time of drilling

Figure A-10

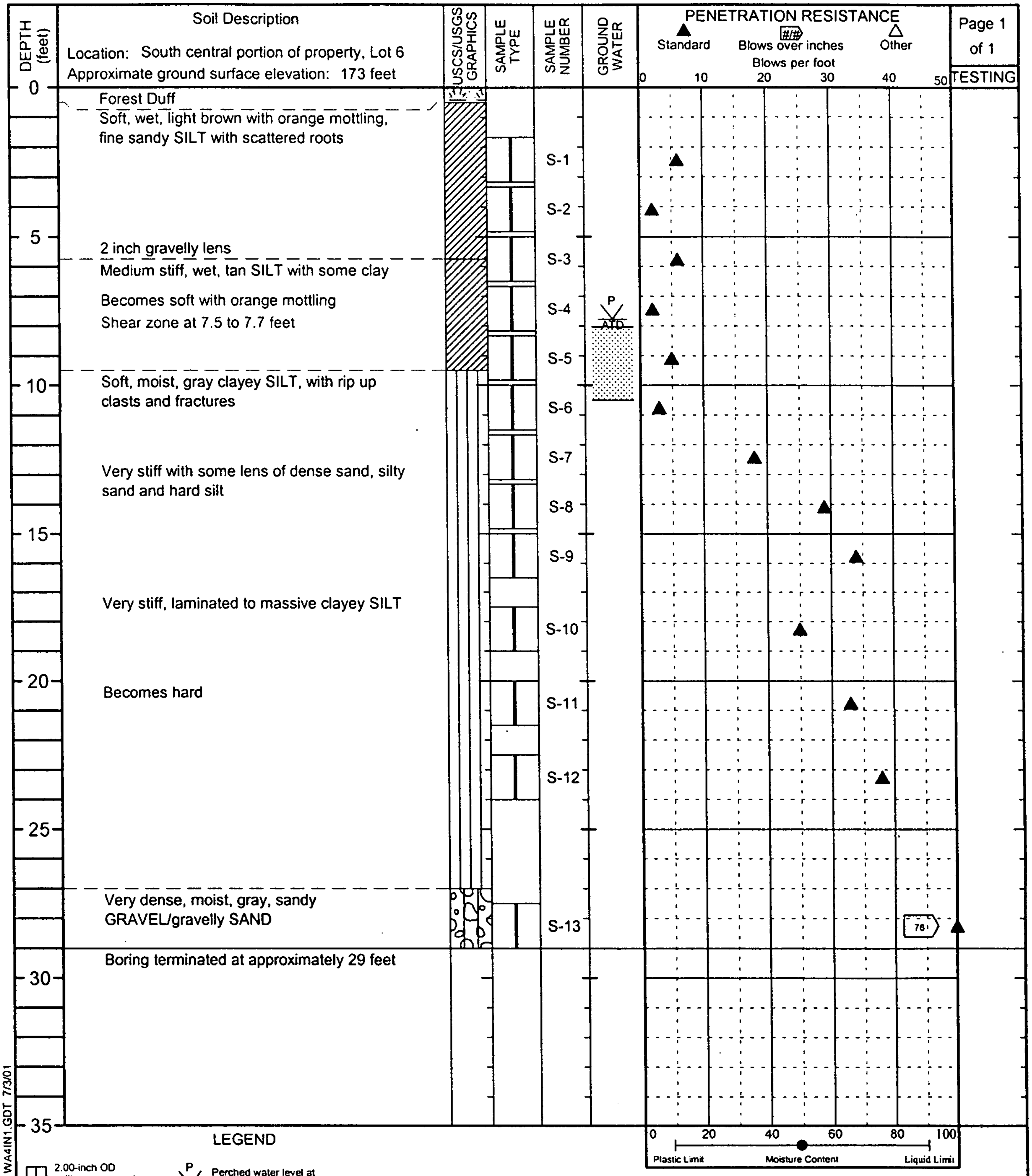
amec

11335 N.E. 122nd Way Suite 100
Kirkland, Washington 98034-6913

4IN1 MERCER.GPJ WA4IN1.GDT 7/3/01

Drilling Method: HSA Hammer type: Automatic Date drilled: *March 27, 2000* Logged By: *KSS*

PROJECT: *Mercer Island Short Plat* W.O. *0-91M-13513-0* BORING No. *B-5*



Soil Description

Location: South central portion of property, Lot 6
Approximate ground surface elevation: 173 feet

Forest Duff

Soft, wet, light brown with orange mottling, fine sandy SILT with scattered roots

2 inch gravelly lens

Medium stiff, wet, tan SILT with some clay

Becomes soft with orange mottling

Shear zone at 7.5 to 7.7 feet

Soft, moist, gray clayey SILT, with rip up clasts and fractures

Very stiff with some lens of dense sand, silty sand and hard silt

Very stiff, laminated to massive clayey SILT

Becomes hard

Very dense, moist, gray, sandy GRAVEL/gravelly SAND

Boring terminated at approximately 29 feet

LEGEND

▯ 2.00-inch OD split-spoon sampler

P / ATD Perched water level at time of drilling

Figure A-11

amec
11335 N.E. 122nd Way Suite 100
Kirkland, Washington 98034-6913

Drilling Method: HSA Hammer type: Automatic Date drilled: *March 28, 2000* Logged By: *KSS*